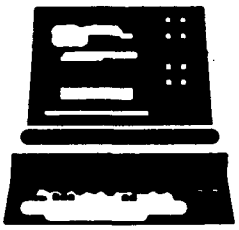

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Distributed Computer–Supported Team Work:

A Research Paradigm

ASQB–GA–90–016

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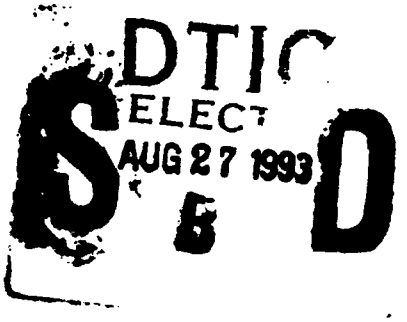

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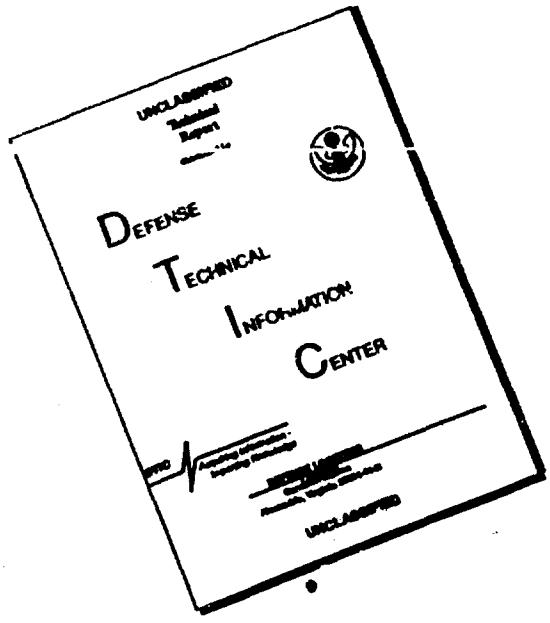

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The research in this report focuses on the viability of distributed, interacting, computer-supported team work and the factors that might impact the effective performance of such groups. Distributed refers to groups whose members are geographically seperated; computer-supported refers to computer software that permits team members to "screen share" as well as exchange files; and interacting refers to groups working synchronously on a task. This report examines the concept of a distributed group; including different configurations of distributed team work and the restrictions they impose on group process.

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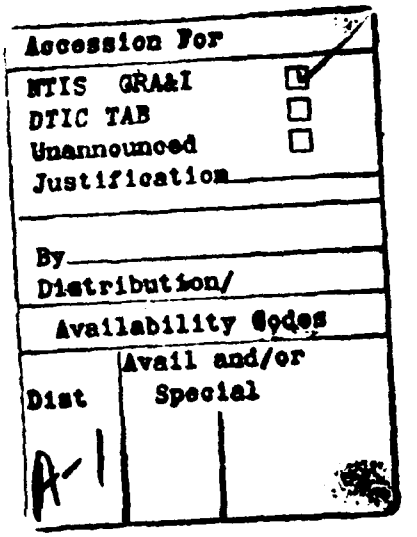

s/ James Gantt
James Gantt
Chief, MISD

s/ John R. Mitchell
John R. Mitchell
Director
AIRMICS

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I. Introduction and Project Goals

Information technology changes over the past 5-10 years have altered the manner in which individuals in organizations accomplish their work. The rapid proliferation of mini and micro-computers that has occurred in many organizations has helped to make end user computing a reality. This decentralization of computing power has permitted organizational members to learn and apply business software tools such as spreadsheets, databases, desktop publishing, graphics, word processing, etc. to the completion of work related tasks, usually in a more efficient and effective manner than the way in which such tasks were accomplished in the past. Indeed, such business software has helped to make computing an increasingly fundamental part of many organizational jobs. One interesting corollary associated with such technology changes is that increasing amounts of work are stored and processed primarily on the microcomputer (e.g., as when all relevant data, analyses, documentation for a given project are completely "filed" and accessed on the computer versus a paper-and-pencil set of files).

While the impact of information technology on organizational work at the individual level has been fairly evident, it is far less visible at the group level. This is not surprising given that the implementation and use of such technology at the group level typically depends both on its establishment and use at the individual level-- an occurrence which has only recently taken place-- as well as the implementation of computer networking capabilities linking end users with one another as well as with corporate computing resources (e.g., printers, databases, etc.). Computer networking capability, which now appears to have become an essential part of most organization's information technology picture, is also a very recent technological change for many organizations.

The manner in which information technology can be used to affect group decision making varies considerably. Dennis, George, Jessup, Nunamaker, & Vogel (1988) provide a useful taxonomy of group decision support systems based on three dimensions: Group Size (small, large), Group Proximity (multiple individual sites, one group site, multiple group sites), and Time Dispersion (all meet at one time, asynchronous meetings). Dennis, et. al. argue that there are six basic categories of electronic meeting systems (EMS) that can be used synchronously or asynchronously. This is illustrated in Figure 1.

Insert Figure 1 about here.

The authors note that the most common form of an organizational meeting is one where a small group of participants meets in one place at the same time. Supporting that type of meeting has been the focus of those who have establishing sophisticated "Decision Rooms" and developed appropriate electronic meeting software (e.g., PLEXSYS) and protocols to aid group decision making (e.g., Dennis, George, Jessup, Nunamaker, Vogel, 1988; Vogel, Nunamaker, George, Dennis, 1988). Here the hardware and software technology is used to control the manner in which group members interact with each other during the accomplishment of group tasks such as idea generation. While the technology usually automates, as well as speeds up, some group processes (e.g., collection and recording of ideas in brainstorming), it also permits groups to "interact" in ways which would not be possible without the technology (e.g., the concept of parallel talk implemented in the electronic brainstorming module of PLEXSYS). While such electronic meeting facilities and tools are indeed useful, they are also expensive to set up, can only be used by one group at a time, and require the physical presence of all group members. Thus, this type of group decision support is likely to benefit only a restricted sample of work groups that exist in organizations.

Another example of how information technology can impact the manner in which groups in organizations work is evident in the popularity and frequency of use of electronic mail systems which usually permit the sending and receiving of both messages as well as files through the computer network. In its plain vanilla form, such E-mail technology acts as an effective, quicker substitute for overnight mail delivery services as well as a means of avoiding "telephone tag" by asynchronously conveying messages which would normally be delivered via telephone. Since E-mail is usually implemented with computer networking, it provides a common groundwork across organizations for supporting collaborative work at all levels in organizations through computing technology. In the Dennis, et. al. framework, this would correspond to the "Local Area Decision Net" environment operating in asynchronous fashion.

We believe that the prevalence of computer-supported distributed team work in organizations fitting the "Local Area Decision Net" classification will increase markedly in organizations, especially for those whose members (and associated skills and abilities) are dispersed over geographically diverse sites (e.g., regional offices) or whose work requires them to be geographically separated (e.g., military assault teams). Moreover, we believe that the recent development of networking software that permits screen, as well as computer, sharing strongly enhances the viability of successfully executing team work in a distributed fashion since it has the potential for making synchronous distributed team work a viable technique. Yet, while such information technology is available, systematic knowledge about how distributed groups may actually use (or should use) computer and communication technology to best accomplish their work is regrettably scarce. This lack of relevant behavioral knowledge about how individuals and groups respond to advanced information technology in turn hinders the development of appropriate groupware and guidelines for computer-supported distributed team work.

Correspondingly, the research to be reported focused directly on the viability of distributed, interacting, computer-supported team work and the factors that might impact the effective performance of such groups. We should note that by "distributed" we are referring to groups whose members are geographically separated, by "computer-supported" we are referring to software that permits group members to "screen share" as well as exchange files, and by "interacting" we are referring to groups working synchronously on their task. As a starting point, we will first consider the concept of distributed groups more closely. Then we will examine several different configurations of distributed team work and the restrictions they impose on group process (relative to face-to-face groups), focus on the configuration that we will use as the basis for our investigations and summarize the purpose and goals of this research.

Distributed Team Work

The concept of distributed team work is not a new one; pressures for working in a distributed fashion cited earlier have existed for quite some time. However, for groups to be able to work in a distributed, as opposed to face-to-face, fashion, there must be some provision for providing communications between the members of the group. We can better understand different means of supporting distributed group performance by considering the nature of communications that occur in face-to-face groups and then consider how different alternative forms of supporting distributed team work compare to that standard.

Face-to-face group interaction provides group members with a rich array of information. The "bandwidth" of communication is wide and includes both auditory as well as visual channels of information. It is useful to further distinguish two informational signals within each of these channels: task and social. Task information focuses on objective information concerning the operation and execution of the task required for its completion. Example of task information would be: dimensions of a particular building design, budget figures for a given project, the particular form of a forecasting model used to generate financial predictions, number of man hours required to complete a given project, etc. Thus, task information would not bear directly on social

relations between group members, cohesiveness, esprit de corps, satisfaction, or any other measure that has affect as its primary component. Instead, we would characterize information relevant to affective concerns as being social in nature. For example, statements of liking or dislike for other group members, denigration of the efforts or abilities of other group members, tone of voice or visual gestures indicating disapproval or approval, are all examples of communications that carry a great deal of social information.

Since successful group task performance will depend on the extent to which the demands imposed by the task (e.g., Hackman, 1987, Steiner, 1972) are met by the group, the relative effectiveness of different forms of technologically supporting distributed team work in facilitating group performance will likely depend on the characteristics of the task facing the group. For example, if a given task actually requires very little in the way of harmonious relations among group members (i.e., the social demands of the task are low), then a relative lack of social information should not be detrimental to successful group performance of the task. On the other hand, if the group task imposes strong interdependencies among its members for successful completion, then a wider bandwidth of information (i.e., social as well as task) may be required for its successful completion. We can illustrate some of these ideas by considering some forms of distributed team work that are now occurring.

Teleconferencing. Perhaps the most prevalent form of distributed team work would be teleconferencing due to its widespread availability (phones are standard equipment) and relative inexpensiveness (no other additional equipment is required). In this case, communications among the distributed group members are synchronous with only the audio channel being open. Task information (i.e., analyses, documents, etc.) bearing directly on the purpose of this meeting will usually have been distributed earlier to group members. In this type of meeting, the auditory channel is open and allows group members to verbally exchange task and social information. Paralinguistic cues (i.e., pauses, inflection, etc.) may also be conveyed and perceived. Details and potential points of ambiguity may also be clarified by the synchronous nature of communication. What is missing in this case is the visual channel of information pertaining both to the task as well as to social considerations. If the task is one which has a strong visual component to it (e.g., illustrations of potential new product designs, information displayed in graphical form), then teleconferencing may not be able to adequately meet the demands of the task and result in poorer performance. Similarly, if a given task invokes a considerable degree of affect on the part of group members (e.g., deals with important values or resources about which there is initial disagreement, requires cooperation among groups who have been rivals, etc.), then the missing visual channel prevents group members from picking up non-verbal information (e.g., looks of disgust, lack of eye contact, body position, etc.) which may be crucial in interpreting other group member's positions and avoiding "misunderstandings" which may detrimentally affect subsequent group interaction and performance.

Video-conferencing. One means of restoring the visual channel is to move from teleconferencing to videoconferencing. Here distributed group members can both see as well as hear each other. While this type of technique does largely succeed in restoring the audio and visual channels of information to that of a face-to-face group, the technology required to do this in-house is costly and still requires group members to travel to their respective video conferencing studios for the group meeting. However, the visual demands of a task may make this the only viable alternative to a face-to-face meeting. For example, in order for store buyers to evaluate the lines of clothing they would like to purchase from their suppliers the buyers need to evaluate the clothing as it would appear on dynamic (in motion) as opposed to static models. In this way buyers can avoid purchasing styles that may look good on paper but do not hang or move nicely on customers. Similarly, if the task demands a great deal of consensus from group members and a strong sense of commitment, then the use of video conferencing allows one to better pick up relevant social information as well as to better convey affective concerns.

E-mail. E-mail is another form of supporting distributed groups that has become viable with the implementation of computing technology. E-mail is asynchronous in nature with both the auditory and visual channels (with the exception of the mail message itself) absent. As such, the bandwidth of communication possible with E-mail is very narrow. For the most part, E-mail is most appropriate for relatively simple, routine tasks which are relatively unambiguous, do not invoke strong affective feelings and conflict, do not impose a great deal of interdependencies among group members, and are not on a particularly tight time frame. When the demands of the group task extend beyond those limits, then the adequacy of E-mail for facilitating distributed group performance is likely to be low. However, the relatively low cost of E-mail, given that computing and networking capabilities have already been implemented, and its relative ease of use makes it a popular form of support for distributed group members.

Teleconferencing with Screen Sharing. Another form of supporting distributed groups is emerging out of recent software that is designed to allow individuals on a computer network to both share their computers as well as their screen displays. The latter capabilities allow distributed group members to show others (by allowing them to observe their computer screen) what they are doing by bringing up relevant task information stored on their computer relevant to the group project. Control of one's computer may also be passed to other group members, allowing them to demonstrate or change things directly on the host's computer (e.g., changing the values of a what-if model to see what happens, drawing an illustration or graph to go with a final report, etc.). Taken in conjunction with teleconferencing, this form of supporting distributed group members succeeds in restoring the auditory channel of information and partially restoring the visual channel by allowing visual task information to be conveyed (presuming that relevant task information is stored on individual group member's computers). This type of process is synchronous in nature and permits the exchange of relevant task documents among group members either through the use of existing E-mail systems or through the file exchange capabilities built in to the screen sharing software directly. Given the prior existence of computers and networking capabilities, the addition of this screen sharing technology is inexpensive.

We believe that the "teleconferencing with screen sharing" form of distributed team work is one that will strongly enhance the abilities of distributed groups to accomplish a wide variety of tasks due to its increased bandwidth of communication (i.e., full audio channel, visual task channel), relative ease of use, low cost to group members (no travel beyond their office computer), and synchronous nature of communication. However, the lack of visual non-verbal information is likely to have a detrimental effect on tasks that exert strong social demands (e.g., potential conflict problems, problems with strong interdependencies).

Purpose and Goals

The purpose of the work outlined in this report is to develop, implement, and pilot test a research paradigm for systematically examining factors that may impact the effectiveness of computer-supported distributed team work. Within this general purpose, we had two goals. First, we wanted to establish a research setting where we could study the factors that lead to effective distributed computer-supported team work. Second, we wanted to investigate how through the use of commercially available software and hardware, we could "patch-together" computers of different architecture and operating system in order to facilitate computer-supported distributed groups working under varying systems.

The remainder of this report will be in five sections. First, we will describe the equipment and software purchased and their functions. Then, we will describe the development of the task and its accompanying software development which was essential for studying group processes that are relevant for the United States Army Information Systems Command (USAISC). Next, we will describe and evaluate the various demonstrations of computer-communication that we tried. This will be followed by a description of the experimentation that we conducted on 4 groups of research

participants who worked on the experimental task. Finally, we will give some recommendations concerning future research and practice.

2. Description of Activities Leading to Goal Accomplishment

In this section we will describe the hardware and software acquired to fulfill the goals of the project, the configurations of distributed groups that it permitted us to test, and the development of the College of Management's Behavioral Laboratory into a computer-supported distributed team work research facility.

Hardware Acquisitions and Functions

Macintosh Systems. Two Macintosh systems were acquired:

1) Mac IIcx 40HD, Apple Extended Keyboard, Memory Upgrade (to 5 MB), Apple Hi-Res Color Monitor, Apple Extended Video Card

2) Mac SE 20HD, Apple Extended Keyboard, Memory Upgrade (to 2.5 MB)

The purposes of these systems were: 1) to develop the task software (conducted primarily on the Mac IIcx system and described more fully in Section 3 of this report), 2) permit Macintosh to Macintosh Timbuktu Remote connections (see configurations subsection), and 3) permit Macintosh to Macintosh Timbuktu Network connections.

IBM Systems. Two IBM systems were acquired:

1) IBM PS/2 70-121, IBM 8513 Color Monitor, 80387 Coprocessor, Procom 1.2mb External Drive, Everex 2400/2 Internal Modem, Daystar AppleTalk Board

2) IBM PS/2 80-111, System Board Ram Kit 80-111, IBM 8513 Color Monitor.

The purposes of these systems were: 1) to permit remote IBM to Macintosh connectivity via an IBM connected to an AppleTalk network, 2) to permit IBM connectivity to Macintosh network.

Communications Hardware. The following communications hardware were acquired:

1) Three Hayes V-Series 9600 baud modems, Hayes V-Series cable for IBM (one to the Spelman subcontractor).

2) Farallon Phone Net Connectors (6)

3) Miscellaneous networking materials (e.g., phone wire, phone wall jacks and plugs, etc.).

The modems were acquired to facilitate remote Mac-to-Mac and IBM-to-Mac distributed group communications. The items listed in 2 & 3 were used to install networking capability in the College of Management's Behavioral Laboratory.

Software Acquisitions and Functions

The software acquired for this project can be broadly classified as being related to either task development or communications.

Task Development Software. The following software was acquired to facilitate the development of the task that groups would be working on: 1) SuperCard (Silicon Beach), 2) MacRecorder (Farallon), and 3) ScreenRecorder (Farallon).

The group budget cutting task was developed within SuperCard, an object oriented application development program which utilizes the SuperTalk programming language (generally regarded as a superset of Apple Computer's HyperCard HyperTalk language). Enhancements in SuperCard over HyperCard that led to its selection as the tool for developing the task software for this project were:

1) ability to have multiple windows showing at the same time on a screen

2) ability to fully utilize monitors larger than the 9" standard screen on the Mac Plus and SE line (i.e., Mac II color monitors, full page displays, etc.)

3) ability to construct and use custom menus in a given project

4) ability to have multiple windows active at the same time on the screen (i.e., floating palettes)

5) ability to convert HyperCard stacks to SuperCard projects

6) ability to generate a stand-alone application

The MacRecorder and ScreenRecorder software were both acquired to facilitate the development of the initial tutorial for group members concerning the budget software and how to use Timbuktu to screen share with other group members.

The MacRecorder allows one to digitally record, as well as modify, sounds recorded through its microphone. These sounds can then be built into an application and invoked at appropriate moments by the program. Thus, instructions can be recorded via the MacRecorder and played back during the tutorial.

The ScreenRecorder allows one to create a "tape" of all events that display on a screen at the user's discretion. Thus, one can make an instructional "movie" that demonstrates all the mouse moves and events required to accomplish a particular task (e.g., how to use Timbuktu). This tape can be invoked during the appropriate moment in the tutorial.

Communications Software. The following communications software were acquired:

1) Farallon's Timbuktu Version 3.0 (4 copies)

2) Farallon's Timbuktu/Remote (2 copies)

Timbuktu 3.0. The Timbuktu software allows group members on a network to exchange files and to share their computers with other members on the network in either an "Observe screen Only" or "Control" mode by invoking Timbuktu (which is installed as a desk accessory and, thus,

available at any time) and clicking the "On" radio button for guest access. All Macintoshs on the network that allow guests are listed in a scroll box and can be chosen by those wishing to "visit".

In the "Observe Only" case, the group member acting as the "host" effectively allows any guest to "peer over his/her shoulder" and see exactly what he sees on his/her screen. In this mode, guests are limited to only one action, which is to disconnect from the host (i.e., stop observing) and return to normal operation of their own system.

In the "Control" mode, group members --or other guests-- signing on to the "host" Macintosh can not only see the exact display of the host machine, but can also remotely control all aspects of the host machine.

Access to the "host" machine is controlled by a password system, with different passwords for different levels of access. The screen of the computer being observed or controlled displays an icon in the right hand side of the menu bar to indicate the presence of a guest observer (icon of a person peering over the corner of a piece of paper) or guest controller (icon of a hand). In all cases, the person whose system is being observed can click on the icon and choose the appropriate "disconnect" guest option from the pull-down menu. If so desired, the host can also make him or herself unavailable to guests by clicking the "Off" radio button for guest access within Timbuktu.

The initial version of Timbuktu that we acquired was version 2.01. This version did not provide the observer with a separate cursor that they were in control of when they were viewing another person's Mac thus making it difficult to move the cursor to the corner to disconnect (the host's cursor was never affected, but his movements would yank the observer's cursor back to the host's cursor location). Version 3.0 addressed that by providing the observer with a separate cursor completely under their control. Version 2.01 also lacked file exchange capabilities. Due to technical difficulties with the installation of the updated version of Timbuktu, the experimental sessions were all run with the 2.01 version.

Timbuktu/Remote. This software package allows a remote Macintosh to connect to another Macintosh system via modem and exchange files, communicate via typing messages in a "Chat-Box" which appears on both systems, or to completely control the "host" Macintosh. The operation of the program is similar to Timbuktu. When used in conjunction with a relay Macintosh connected to a network, it allows the remote group member to participate as if he were directly connected on the network.

Computer-Supported Distributed Team Work Configurations

The hardware and software acquired for this project allowed us to examine a number of computer-supported distributed team work configurations. These are described below.

Distributed, Interacting, Screen Sharing Teams, (Network Timbuktu). In this configuration, group members are all connected via a network but are physically separated from one another (e.g., all on different floors of an office building). Phone communications are available and screen and computer sharing is available through Timbuktu. The group meeting in this case occurs in real time via conference calling and immediate sharing of visual task information via Timbuktu. This type of configuration is one that may emerge as a predominant model of how groups may work in the near future and is a primary focus of attention for us.

Distributed, Interacting, Screen Sharing Teams, with Remote (dial-in) Member (Network and Remote Timbuktu). This configuration is identical to the above but with the addition of a relay networked Macintosh that is equipped with Timbuktu/Remote. This

permits a group member to connect to the network via modem and participate in an identical fashion to the previous scenario by controlling the relay Macintosh system.

Distributed, Interacting, Screen Sharing Teams with Remote (dial-in) Members (Remote Timbuktu). In this configuration, none of the Macintosh systems are networked together. Instead connections are established via Timbuktu/Remote on a pairwise basis.

Distributed, Networked, IBM-Macintosh Mixture. This configuration mixes both Macintoshs and IBM systems on an Apple Talk network with the IBM systems equipped with an Apple Talk board and a compatible mail system (i.e., Microsoft Mail). In this case, communications with the IBM systems are limited to E-mail and file exchange.

Distributed, Networked, IBM-Macintosh Mixture,with Remote IBM System. This configuration is identical to the previous one, but with the addition of a remote IBM system that connects to a relay IBM system on the Apple Talk network.

College of Management Behavioral Research Laboratory Modifications

To empirically examine some of the computer-supported distributed team work configurations described above requires an appropriate laboratory facility. The College of Management supports a Behavioral Laboratory which consists of a suite of 4 small rooms (capable of comfortable seating 4-8 members), 1 large room, and a control room with one-way mirrors permitting unobtrusive observation and recording (via the facility's video recording equipment) into all other rooms.

Modifications undertaken in the behavioral laboratory to facilitate the examination of distributed group performance include the following:

1) Installation of six phone lines into the control room and phone jacks in all experimental rooms. Routing of the six phone lines into the experimental rooms is flexibly accomplished within the control room, thus permitting different configurations of computer-supported distributed team work performance.

2) Installation of two additional phone jacks in each of the experimental rooms for implementing an Apple Talk network. This particular configuration allows us to quickly reconfigure the network configuration linking the various experimental rooms to one another.

Figure 1 provides a schematic diagram of the College of Management's Behavioral Research Laboratory with the modifications described above. As can be seen, the Behavioral Research Laboratory now provides an ideal facility for systematically setting up and investigating issues surrounding computer-supported distributed team work.

Insert Figure 2 about here.

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3. Task Development

Task Design Considerations

To investigate the computer-supported distributed team work scenario that we are focusing on (teleconferencing with screen sharing), required the development of a computer-based task

which fulfilled a number of desirable characteristics: a) relevance to United States Army Information Systems Command (USAISC) distrib ted team work situations, b) possession of a sufficient degree of task complexity, c) interdependencies between individual group member tasks, d) ability to build in potential conflict within the parameters of the task, e) ability to implement screen sharing. The budgeting task that we eventually developed incorporated the desired characteristics. We will describe how in the paragraphs and sections to follow.

USAISC Relevant Task Scenario. We began the process of task development by discussing possible scenarios for computer-supported distributed team work that the U.S. Army was likely to face with Dr. Jim Gantt of AIRMICS. Through those discussions, we selected a budget adjustment scenario where regional managers are faced with implementing an overall budget cut across their regions and the projects taking place in each. This type of scenario was one that currently exists, often took place on a short time frame (typically precluding face-to-face meetings), and involved distributed team members who communicated relevant task information over the telephone. In such situations, failure to adequately communicate or process task relevant information during group interaction can result in errors in budget reduction decisions. For example, the postponement of a project (e.g., radio communications device) in a given region from the current budget to the next year's budget is one way of reducing the current budget. However, this approach does yield problems when the postponed project was supposed to produce a product to be used in a project in a different region that was not postponed (e.g., tank production). Ideally, such errors should be caught by the group. However, time pressure and the relatively narrow bandwidth of communication permitted by telephone interaction may be contributing factors that can hinder the identification of such task interdependencies and result in poorer distributed team budget decisions.

To further aid the development of our task and our understanding of the budgeting process, we requested meetings with USAISC personnel who participated in such budget adjustment decisions. Unfortunately, we were unable to arrange such a meeting within a reasonable amount of time. However, we did meet with Barbara Walsh, a budget specialist with the Georgia Tech Research Institute (GTRI). She described to us her experiences involved in dealing with similar types of budget adjustment decisions and the overall budgeting process for GTRI. We were also able to meet with Ron Creswell, also with GTRI, who demonstrated some of the project budget management software that he had developed in Lotus 1,2, 3. This information was used to ensure that the budget adjustment task we subsequently developed would be reasonably analogous to such tasks currently existing in organizations.

The scenario subsequently adopted for the task was a budget reduction situation involving three regional managers of a fictitious organization who are informed that they are to collectively cut 30% out of their overall combined budget. Decisions as to how and where budget reductions are to be taken is left to the regional managers, who each manage a portfolio of five projects totaling $2.5 million.

Each of the fifteen projects were assigned rankings (ranging from 1-15) reflecting its priority (importance) to the organization as a whole. In addition, each project within a given region was also assigned regional priority rankings (1-5) which only the manager of that region was privy to. The two sets of rankings permitted us to set up situations in which the regional priorities conflict with organizational priorities. This conflict becomes important when the group as a whole has to identify appropriate projects to cut to attain the 30% budget cut goal.

Regional managers are able to access specific budget information of each of the projects they manage including detailed breakdowns of expenditures (via appropriate spreadsheets) and specific descriptive information (both for public as well as private consumption). Modifications to the budgets of the projects assigned to them was accomplished via the spreadsheets which handled

the relevant calculations necessary. The sample computer task session will be illustrated in a later section.

Communications between the Regional Managers are possible via telephone (each manager had a phone on his desk with preprogrammed numbers for other Regional Managers) and screen sharing via their computers (networked Mac II's). Instructions concerning how to use the phone to contact the others, how to set up a conference call, and how to use Timbuktu to screen share were given prior to task performance.

Task Complexity. As noted above, each regional manager controlled the budgets of five separate projects. Each of these project budgets contained the following line items: personnel, equipment, materials & supplies, travel, and subcontractors. The total expenditures for each of these respective line items were detailed in separate spreadsheets. The project description information (both public and private) for each of their five projects was available for review by the Regional Manager via a database-like function. In some instances, this information indicated the presences of interdependencies among the five projects which served to further increase the level of individual task complexity. In addition, task interdependencies between projects across group members (described below) and conflicting organizational (reflecting the importance to the organization) and personal priorities (reflecting the importance for the individual group member in his region) for the projects.contributed to both the task as well as social complexity of the demands facing the individual group member.

Interdependencies Between Individual Group Member Tasks. This was accomplished via the project description information which noted the projects on which the current project depended. For example, a given telecommunications product might depend on the development of telephone switching components. This information was used to establish interdependencies between the projects of different Regional Managers. Thus, decisions to cut or substantially reduce a given project needed to be based not only on the merits of the individual project, but on the merits of those depending on it as well.

Development of Conflict Within the Parameters of the Task. The overall budget for the portfolio of five projects assigned to each Regional Manager was set to be identical (i.e., $2,500,000) so as to foster an initial sense of equality among the Regional Managers. However, the organizational priorities assigned to each of the projects (See Appendix A) were set up such that the portfolio of projects for Region 3 consisted almost entirely of low priority projects. Thus, the bulk of any organizational level budget reduction would be most appropriately taken out of Region 3. Each Regional Manager also received "classified" information concerning their "regional" priorities (e.g., their regional boss' preferences) for each of the five projects they were managing (See Appendix A). This information was used to further instill potential points of dissent between Regional Managers about cutting certain projects through the use of conflicting organizational and regional priorities. For example, one of the low organizational priority projects held by the Region 3 manager was also his/her highest regional priority.

Ability to Implement Screen Sharing. The capability to screen share was accomplished by using the desk accessory based program "Timbuktu" (described earlier in the communications software section). The initial design of our task included a "Communications Window" interface that permitted the easy use of screen sharing (via Timbuktu) by the Regional Manager.

Task Software Development

The task software,with the exception of the screen sharing capabilities (implemented via Timbuktu), was developed entirely within the context of SuperCard. The initial portion of the task software consists of an introductory series of screens which collects information about the subject

(name, student ID number) and describes the task scenario and regional manager role that the subject will be playing. This segment of the program is illustrated in Appendix B.

The primary portion of the task software consists of the various windows that implement the different aspects of the budget adjustment task. These windows are illustrated in Appendix C along with the scripts for the buttons and fields that are contained within them as well as a general description as to their purpose. Also embedded into the script for buttons, spreadsheet fields, and windows were some segments designed to "trap" responses. These were immediately written to another file as they occurred. When the session was over, summary totals were also calculated and written to the file. Thus, a chronological tracing of how the budget task was completed was available for every participant.

Sample Task Session

The actual operation of the program is best described by reviewing the sample task session for Region 2 illustrated in Appendix D.

Screen 1- Upon completion of the initial introduction to the task and software training session (conducted in a separate room on a different computer--see Methods Section), each Regional Manager was faced with the screen shown.

The "Budget Allocations" window appears in the upper left-hand corner of the screen. This window displays the original and revised budget allocations for each of the three regions. Fields which are patterned (with dots) are those which the Regional Manager can make changes. In this case, any changes in the revised budgets for Regions 1 and 3 are to be entered by him. That information is obtainable by either calling or viewing the screen of the managers of the respective regions. The revised budget for Region 2 cannot be directly modified in the budget allocation window since it is dependent on changes made in the project spreadsheets and is automatically calculated. Percentage pie charts of the original and revised budgets for the three regions is also viewable by "clicking" on the appropriate "Original" or "Revised" column heading. This window was programmed to be non-movable, non-closable, and always active (floating palette).

The "Communications" window appears in the upper right-hand corner of the screen. This window was originally constructed to permit easy access to Timbuktu's screen sharing functions. The left portion controlled which Region you wished to observe. The middle section controlled visitor's access to your screen (i.e., visitors allowed, or not allowed). The right-hand section of the window simply contained a reminder that one could disconnect from viewing another Region's screen by "clicking" on the scissors icon that would appear in the upper right-hand corner of their screen. However, after discussions with the technical support people at both Silicon Beach (SuperCard) and Farallon (Timbuktu) it was determined that it would not be possible to simplify access to Timbuktu in this fashion (SuperCard does not currently permit the execution of desk accessories--a limitation currently being addressed by Silicon Beach). Instead, Timbuktu access was implemented by constructing a custom menubar consisting only of the Apple Menu which contains Timbuktu, as well as other, desk accessories. This window was programmed to be non-movable, non-closable, and always active (floating palette).

The "Project Directory" window displays summary budget figures for each of the projects as well as information concerning the project name and manager. Detailed information about a particular project is obtainable by clicking on the appropriate project ID number. This window was programmed to be non-movable and non-closable.

Screen 2- This shot illustrates what the screen looks like after the "Original" and "Revised" column headings in the "Budget Allocations" window are clicked on. Note that since there have been no changes as yet in the budget figures that the pie charts are identical. When

budget changes are made, they are immediately reflected in the "Revised Allocation" figure. Both the "Original Allocations" and the "Revised Allocations" windows were programmed to be non-movable and always active. The presence of the close box (upper left-hand corner of each window) indicates that users can close these windows to free up the space if they so desire.

Screen 3- This shot illustrates what the screen looks like after the user has clicked on "B1000" in the "Project Directory" window. The "Project Summary" window for B1000 puts the Region location, Project ID #, and Project Manager in the title bar of the window and contains two primary segments. The left-hand side of the window contains a summary spreadsheet of the line item expenses for this project. The lack of any patterning indicates that no changes can be made directly to the cells of this spreadsheet. Instead, changes are made by "clicking" on a given line item name to open up the spreadsheet for that item detailing the expenditures. This will be more fully illustrated in Screen 5.

The right-hand portion of the screen displays a scrolling field that contains general information about the project. The button below this field allows the Regional Manager to access "classified" or personal information about the project which are intended for their eyes only. This button was programmed to not permit access to the "classified" information if "Observers Allowed" was checked in the "Communications" window. If "Observers Allowed" was instead checked, clicking on the button would bring up a warning message, rather than the classified information field, which would ask the manager to not permit any observers first before accessing this field. Upon closing the "Project Summary" window, the classified information field would again be hidden. The "Project Summary" window is programmed to be closable, but non-movable.

Screen 4- This screen shot illustrates what happens when the Regional Manager clicks on the "Display Classified Information for Project" button. The hidden scrolling field containing the classified information is brought to the front and completely covers the general information field. Information contained in this field are the Organizational and Regional priorities for the project as well as other relevant, albeit not public, information. When the classified field is visible, the "Display Classified Information for Project" is superimposed by a "Hide Classified Information for Project" button which allows the manager to do just that. If the classified information field is showing when the user clicks on the "Observers Allowed" option in the "Communications" window, then the program automatically hides the classified information.

Screen 5- This screen illustrates what happens when the Regional Manager clicks on one of the line item names (in this case "Personnel") in the summary spreadsheet section of the "Project Summary" window for Project B1000. The "Budget Itemization" window displays the appropriate card containing the detailed spreadsheet information for the line item name that was clicked on. This window was programmed to be non-movable, closable, and always active. You'll note by the patterning in the cells in the "Revised" and "% Cut" columns that the Regional Manager can only make changes there. The spreadsheet is set up so that any change in a given line automatically calculates the appropriate other change. For example, if the Regional Manager types in a particular dollar amount for the revised budget for a given line, then the appropriate percentage cut figure is calculated and inserted in the appropriate adjacent space. Similarly, if the manager types in a particular % cut figure, then the dollar amount of that cut is subtracted from the initial budget and the appropriate revised budget number is inserted into the appropriate adjacent cell. Warnings for invalid entries (i.e., revised budget amounts greater than the initial amounts budgeted, and percentage cuts greater than 100%) are given with the affected cells then being restored to either the initial budget amount (for cells in the revised column) or to 0% (in the % Cut column). In all cases, changes made in these line item spreadsheets are immediately reflected in the "totals" line of that spreadsheet (i.e., last line), the budget summary spreadsheet of the "Project Summary" window, the appropriate spot in the "Budget Allocations" window (i.e., for Region 2), and in the pie chart shown in the "Revised Allocations" window. In the latter cases, we can also see that the

Region 2 Manager has gotten in contact with the Region 1 and Region 3 managers and obtained their current revised budget amount for their respective regions (see "Budget Allocation" window). We can also see that the 66% change made in the personnel budget of project B1000 has also been reflected in the "Budget Allocations" window. All of these changes are also reflected in the "Revised Allocation" pie chart which now shows the relative distribution of organizational dollars across the regions.

The "Undo All Cuts" button allows managers to completely undo all changes at once for the given spreadsheet. This was designed to facilitate the easy correction of mistakes and to permit private "what-if" budget adjustments that could quickly be removed when observers were present. The "Show Cut Priorities" button brings up a window containing the organizational priorities for cutting certain items within a given budget category (e.g., personnel).

Screen 6- This screen shot illustrates the "Cut Priorities" window for personnel. This was designed to provide a guide to the Regional Managers concerning the relative general organizational importance of the different items appearing in a given detailed spreadsheet. This window was designed to be non-movable, closable, and always active.

Budget Task Revisions

The sample task session reviewed in the previous section illustrates the version of the budgeting task software that was used for the final experimental session (4). That version incorporated some revisions that were implemented after the first day's experimental sessions in response to participants' debriefing comments as well as our own personal observations (for further details see "Findings: Group Process" in the "Experimentation" section). The software and experimental procedure revisions were:

1) Centralizing of all classified information for a given project in one field so that it could be accessed quickly by one button push at the level of the "Project Summary" window (see Screen 4 of Appendix D). Previously, classified information for a given budget line item was accessible only from the appropriate card in the "Budget Summary" window. Participants complained that a great deal of work had to be done to fully examine all of the classified information for a given project. Moreover, not all of the budget line items had classified information associated with it; a fact which participants could only discover by going through all the procedures to open that classified information field. Centralizing the classified information succeeded in addressing that problem.

2) Putting both the organizational and regional priority information about a given project in a prominent location in the classified information field (see Screen 4 of Appendix D). This was done to highlight the potential conflict that might exist for a given regional manager between the projects that while low on the organizational priority totem pole, was highly valued in their region.

3) Distributing to participants a summary sheet detailing the organizational priority rankings of all 15 projects across all of the three regions (see Appendix A). Prior to this change, the organizational priority information about a given project was contained in one of its budget item classified information fields. Thus, each regional manager knew the organizational priorities for his projects, but not for the other 10. We assumed that information would be communicated as part of the group problem solving and decision making process. This was apparantly too subtle and did not take into account that some of the regional managers might prefer that the others did not immediately know what the organizational priorities for their portfolio of projects were. To aid managers' ability to identify those projects which were prime candidates for

budget cutting, we decided to distribute that information at the beginning of the actual task session.

4) Altering the required amount to be cut from 30% to 20%, but with the added restriction that only low organizational priority projects (8-15) could be cut. This change was implemented during session 4 and was designed to further create an imbalance between regions with regards to the budget reductions they could put in place in their own region and to increase awareness that further cuts would have to come from certain regions. The changes resulted in Region 2 having only one project that could be cut, Region 1 having two, and Region 3 having four out of five that were cuttable. We anticipated that these changes would result in individual managers ascertaining more quickly that they needed to contact the other regions to be able to accomplish their group task.

4. Demonstrations of Feasibility of Distributed Team Work Configurations

Distributed, Interacting, Screen Sharing Teams, (Network Timbuktu)

The first set of trials with Timbuktu were conducted in the Classroom-2000 facility, College of Management, Georgia Tech. In this facility there are 35 MACIIs networked for instructional purposes. The underlying Local Area Network used is Ethernet. All the MACIIs have Ethertalk cards installed. The data transfer rate in this network is 10 Mbits/second. This trial run, conducted with 4 MACIIs, was useful for familiarizing the researchers aware of the limitations of Timbuktu.

The following items regarding Timbuktu were observed:

- The color information on the observed MACII's screen was not transferred to the observing MACIIs. Hence this precluded the use of color in the development of the task software.
- One user could observe any other single MACII.
- Several users could be observing the same MACII.
- There could not be any daisy chaining of MACIIs, i.e., a user A could not observe another user B who, in turn, was observing a third user C.
- The need for a means of communication between users was felt. The Classroom 2000 facility has no phones. The remote version of Timbuktu has a message note pad which the users at the two sites can use to exchange messages in case they do not have a phone connection available. The network Timbuktu tested in Classroom 2000 does not possess this feature.

Distributed, Interacting, Screen Sharing Teams, with Remote (dial-in) Member (Network and Remote Timbuktu)

This demo involved three MacIIs (see Figure 2). A remote MACIICX (Computer A) was used to dial in to a MACIICX (Computer B) using a 9600 bps Hayes V-Series modem. The dialing in was done via Remote-Timbuktu. The second MACIICX (Computer B) was one of a number of computers which were connected to the College of Management's AppleTalk local area

network. Computer A had control over Computer B. Computer B was programmed to answer the phone in 1 ring. The following were observed:

- File transfer using Timbuktu between the two computers was tested and proved to be successful.
- The message note pad available in Remote Timbuktu proved to be a useful feature.
- The use of Multifinder in the Macintosh operating system of Computer B caused the system to crash. In order to conduct further tests, Multifinder was disabled in all the MACIIs.
- A few other system features not germane to the task were disabled from the computers; a Type Manager program and a clock desk accessory.

Insert Figure 3 about here.

The AppleTalk network operates at 375 Kbits/second (much slower than the Classroom 2000 demonstration just described). Then a regular Timbuktu connection was established between Computer B and another MACII on the AppleTalk network. When this second connection was established, Computer A could control Computer C. The project (budget) software, written in SuperCard, was then run on Computer C. The major point that emerged was:

- Since this experiment was conducted on a regular working day, the AppleTalk network was busy and the response time to see the effects of issuing a command to the budget program was very slow. Whether the delay is due to the 9600 bps phone link or to the traffic on the AppleTalk network was not established.

Distributed, Interacting, Screen Sharing Teams with Remote (dial-in) Members (Remote Timbuktu)

The communications software, Timbuktu, comes in a remote version allowing computers to send files, pass messages in a "chat box" and have remote control through the telephone system. We had purchased 9600 bps modems in order to determine whether the operational aspects of remote Timbuktu made computer-supported distributed group work feasible through the telephone network.

In a sequence of trials, we communicated at 1200, 2400, and 9600 bps. The Timbuktu Remote manual recommends 9600 bps. Our experience would bear this out. At 1200 bps, all functions were extremely slow. At 2400 bps, the functions were improved, but probably would be rarely used except by people with a great deal of patience. At 9600 bps, the functions were acceptable, though still somewhat slow relative to the performance of the network version described above. We would expect that most users would have access to 2400 bps modems (because of their relatively modest cost). The widespread use of packages such as Timbuktu-Remote will probably depend on lower prices for 9600 bps (and possibly faster) modems.

Distributed, Networked, IBM-Macintosh Mixture,with Remote IBM System

Attempts to connect the IBM machine to the Apple LocalTalk network through a modem to achieve "seamless" interface have been only partially successful.

At the College of Management (COM) facility, an IBM PS/2- model 70, with a DayStar Digital AppleTalk board for Micro Channel, was connected to the Apple LocalTalk network. This

network hosts all the Faculty/Staff Macintosh computers, AppleShare hard disks and a variety of laser printers. It is also connected to Georgia Tech's GTNet by Fastpath InterBridge, which in turn is connected to a dozen other LocalTalk zones. With Microsoft Mail 2.0 running both on this PS/2 node and a Macintosh server, we could send and receive mail, graphics and files. This PS/2 workstation also has an Everex 2400 bps modem so that it could be accessed by a remote IBM PC or PS/2 through telephone.

At the Spelman subcontractor's site, all machines on the PC LAN and Token Ring networks share a single server. The subcontractor is using PC-Chalkboard Plus to communicate with students over the network. PC-Chalkboard Plus allows the "Teacher" to broadcast the teacher's screen to all the students' screens. The "Teacher" can also "Peek" at a student's screen and control the student's machine remotely. If desired the "Teacher" can broadcast a student's screen to all the other students. There are pieces of software which have been reviewed, Close-Up Lan, Close-Up Support/ACS and Close-Up Customer/Terminal which allow for communication between computers on IBM compatible networks connected through modems to communicate in a manner like the computers using PC-Chalkboard Plus on the bridged PC LAN and Token Ring networks.

The subcontractor is also currently involved in a separate project connecting AT&T machines on an Ethernet by means of a Broadband LAN to the machines already connected together through the bridged networks. This gateway is being created with an Allen-Bradley Network Interface Module in the server for the already bridged networks. Novell software is being used to have machines on the three networks communicate with each other. The Unix machines on the Ethernet will run Novell software within a DOS shell to connect to the server connecting the two bridged networks.

From our current experience with commercially available products, we found that we will be able to
i) communicate by a "chat box" and send/receive files between two IBM PS/2 workstations using the telephone;
ii) communicate and send/receive files between an IBM PS/2 and a Macintosh computer in a LocalTalk network using Microsoft Mail 2.0.

The above two capabilities together imply that it is possible for a member of the group at a remote site using an IBM PS/2 or PC, to take part in a budgeting session. However, the budgeting software written using SuperCard for Macintosh computers will not be readily available to the remote member. We contrast this situation to the case when the remote member also was using a Macintosh.

Currently, the modem software and the AppleTalk MC board's software running on the relay PS/2 workstation do not interface with each other. Hence, one human being is needed to relay the information. However, it is possible to write some batch files, (say modem.bat) to initiate the remote session, which upon termination automatically executes the instructions relayed through modem during the session. Though it is conceptually feasible, it needs to be tested. We also learned, through a vendor, that if we use the TOPS network for connecting the Macintosh computers then the Shiva Net Modem will let a remote IBM PS/2 directly access the network. These two ideas need to be explored in future.

V. Experimentation

Description of Research Setting

A key goal of this research project was to develop a laboratory setting where research on computer supported team work could take place. To this end, the facilities described in Section 2 were modified, a computer network installed, phone lines installed, and so forth. The task described in Section 3 was developed to both demonstrate the feasibility of team problem solving through computer-supported facilitates and to actually observe groups trying to solve the problem. Therefore, 4 experimental groups were recruited to participate in the study.

Method

Participants

All participants were Ph.D. students from Georgia Institute of Technology. Four students were from the College of Management and eight students were from the School of Psychology. We recruited these students because we wanted individuals who would cooperate with our extensive debriefing needs and also would participate in a situation where the software/hardware configuration was still somewhat untested. We had found through initial tests of the equipment that system crashes and logical errors were possible. We wanted our participants to be tolerant of these flaws and to allow us to "reboot" the system and continue their work.

Each experimental session began with 3 participants showing up at the appointed time and room. They all understood that the session would take about 2 hours. The participants sat in the large experimental room while one of the researchers explained the basic nature of what was going to take place. They were instructed as to the sequence of events, their role as "pilot" subjects, the operation of the software, and the debriefing to follow.

After initial instruction, questions were answered. Next, each of the participants was lead to an experimental room where the computer was set to give further explanation of the role the individual was to play in the study (See Appendix B). A fictitious company was described which had a Research & Development budget that was allocated over 15 projects. Each of the 3 participants represented a regional manager and was in charge of 5 project budgets. The projects were listed by name and organizational priority (Sec Appendix A). Further information about each project was to be found in the budgeting software that would be learned and used during the course of the study.

When each participant had finished reading the introductory notes, they were asked to call "Training Headquarters" which was the control room for the Management Research Lab. When all calls had been received, the researchers called all of them back and asked them to come down to training headquarters where the training demonstration would take place.

The training demonstration consisted of a computer that had the budgeting software installed with some regions and projects different from those that the subjects would be working with. One of the researchers then demonstrated the various functions of the budgeting software. Demonstrations included opening the graphics windows, the project budget windows, the budget line windows and so forth. Changes in budget lines were demonstrated. For those participants who had not used a Macintosh Computer before, they were given the chance to use the "mouse" to move the cursor and change entries in the budget line windows.

Instructions were also given on using the Timbuktu "screen-sharing" capability. Because of some software incompatibilities it was impossible to have a single button push to connect to other regions. Rather, the participants had to invoke Timbuktu via the desk accessory menu bar.

In addition to the budgeting software and Timbuktu demonstration, the "training session" also included instructions on using the conference calling features of the phone system as well as further details about the scenario they were taking part in.

After the training session, the participants were led back to their respective rooms and told that they would have about 45 minutes to complete their targeted cuts.

At this point in time, all participants were left on their own. If they called training headquarters with questions, they were answered. If they had a software crash, the researchers could see this from the control room and would walk over to the appropriate room and "reboot" the system. The budgeting data base was updated in real time so that even when the system crashed the budget revisions were saved and retrieved on reboot.

As the session reached the 30-40 minute mark in elapsed time, all of the participants were notified of the time remaining. Because of the exploratory nature of these sessions, we didn't restrict the sessions to 45 minutes. If progress was being made and the groups appeared to be moving into a stage of discussion whereby the Timbuktu software might be accessed, the groups were allowed to continue.

Observation and Measurement.

Researchers remained in the research lab control room during the sessions. All participants were visible through one-way mirrors. In addition, experimental room intercoms were turned on so that conversations could be heard. On the second day's sessions, the participant playing the role of the Region 3 manager was video-taped.

Debriefing. After the session was complete, the participants were brought back to the large lab room and debriefed. This debriefing consisted of a series of questions concerning:

1) member strategies concerning the task
2) use of the Timbuktu screen sharing software
3) coordination of efforts
4) perceived difficulty of the task
5) interest in the task
6) perceived conflict inherent in the task
7) anything else that they thought relevant

Each participant's final revisions was obtained by saving their final version of the budgeting software data base and recording the final numbers. Each participant's software use history was obtained by "trapping" all button pushes and field accesses. This history was then summarized by totalling the number of accesses to each project and the line items within budget.

Given the exploratory nature of this research, we attempted to gather a wide range of data and information about how the sessions went. We did not measure and observe in the hopes of testing hypotheses but rather to get a better feeling about how the experimental sessions went and how individuals within these session could suggest modifications to both the scenario, the training, and the software.

Findings

Group Process

The first set of findings concerns the group process observed during the sessions. During sessions 1 & 2, it was notable that no attempt was made to communicate to each other (through phone or computer) until about 30 minutes of individual work on the project budgets. Upon debriefing the participants about this afterwards, we were told that it took about that long to learn about the projects. In part, this was because much of the information about a project was

accessible only through pushing the classified information button for each budget line item. In addition, the participants told us that they all assumed that they were each supposed to cut 30% from their projects. Although we had given Region 3 far more low priority projects, the participants told us that the equitable approach was to all cut 30%.

Because the intent of the task was to make it a "group" task with some inter-member conflict, we changed both the software and the scenario for the second day (sessions 3 & 4). The changes involved moving all classified information from the budget line level to the project level. This resulted in the participant being able to read all classified information about a project at one time. More detail on these changes can be found in the section of this report titled "Budget Task Revisions". The second change involved giving each participant a list of all 15 projects (across the three regions) and their organizational priorities. It was thought that this would make the difference in priorities between regions much more salient and therefore the group members would want to establish something other than equal shares of the budget cuts.

Session 3 during the second day progressed much the same as the sessions during the first day. There was one early phone call between regions 2 & 3 almost immediately after the participants returned to their offices from the training headquarters, but this was very brief. The participants were only deciding to work on their projects individually first and later to talk about the overall task. The first conference call occurred about 30 minutes later.

For the final session (#4) we altered the scenario (once again) to try to invoke more information sharing earlier in the session. We stated that only projects with organizational priorities 8 to 15 could be cut and that the overall cut would have to be 20%. This change created the situation that the Region 2 manager had only one project that could be cut and the Region 1 manager had 2 projects that could be cut. On the other hand, the Region 3 manager had 4 (of 5) projects that could be cut.

Interestingly, this scenario created the situation whereby the Region 2 manager very quickly cut what she though was appropriate from her one low priority project. Then she looked for another role to play in the group (learned from debriefing). She telephoned Region 3 to ask what she could do to help. This then led to the use of Timbuktu to observe what Region 3 had on his screen. Some of this observation was done while talking on the phone. Other parts of it was done passively (e.g. without phone contact).

The group soon engaged in conference calling and began to share information about cuts. The Region 1 manager had decided to cut from some of the untouchable projects (priorities 1 to 7). The Region 2 manager told him this was not permitted and the budgets were restored.

Group Performance

Performance was assessed by how close the groups came to meeting the required percentage of cuts. These results appear in Table 1. As can be seen, in Session 3, the Group achieved cuts of 26.9% (out of a goal of 30%). Interestingly, the group in Session 4 achieved an overall cut of 7.8% (out of a goal of 20%). This group was working under the restriction that they could only cut from projects with priorities 8 - 15. As noted above, this restriction meant that the person in Region 2 only had one project to work on and this project was cut by 29.1%.

Insert Table 1 about here.

Another way to look at the budget cutting is to see what accounts for the differences in percentage cuts taken in the project budgets. This can be done by using a multiple regression

procedure whereby the % cut is the dependent variable and the independent variables are starting budget and the various cues that we built in concerning what the priorities were as well as interdependencies between projects.

These regressions are very tentative given the small number of observations. We look at them only for purposes of further describing the data obtained and not for purposes of making inferences to populations. We used multiple regressions on the first 3 sessions combined as well as each of the 4 sessions individually. The results appear in Table 2. The multiple R^2 is frequently interpreted as the degree of model fit. For the first 3 sessions combined the R^2 was .14 which suggests that the group members were not making their cuts according to the "cues" we built in. However, when we broke the groups out separately, the first group had an R^2 of .47 which suggests a pretty good fit. The second group had an R^2 of .05 which is a very poor fit. Finally, the the third and fourth groups had an R^2 of .60 and .80. These latter two numbers are comforting because they suggest that our changes in procedure between the first and second days improved the salience of the cues.

Insert Tables 2 and 3 about here.

The poor fit for the second group can be better understood by looking at Table 3 which displays the number of times each individual accessed a project and a line item within a project. Although, some data were lost because of system crashes, it is clear that the participants in Session 2 showed less activity than the participants in the other sessions. Reports from the Session 2 participants suggests that the budget-cutting task was novel to them and using the Macintosh computer was a new experience. This probably caused them to spend more time becoming familiar with the software and perhaps indiscriminantly cutting as opposed to sharing information about project priorities.

Software and Use

Through observation and debriefing, it was obvious that the participants took quite a bit of time to become familiar with the operation of the software, especially those who had neither budgeting experience nor Macintosh experience. One participant spent much of the time learning how to operate the software.

The Timbuktu software, likewise, created some impediment in its operation. The operation of the menu bar option along with the options concerning "observe", "control", "no observers" mode did probably prevent experimentation with it by some groups. Upon debriefing, groups usually said that they didn't feel the need to share screens. That is, so much of their time was taken up learning about the projects and cutting the 30% which became the expected amount, that they never reached the stage where the task was group work that might have benefited from the screen sharing capacity. The conference phone calling provided a satisfactory means of exchanging information.

It became clear that both the budgeting software and the Timbuktu software operation would benefit from further training. Some of the participants suggested that we have a session devoted strictly to software training.

There was one comment about the response time of the software. The Timbuktu software, when in use, does tend to slow down the operation of the computer being observed. In addition, the SuperCard software, in which the budgeting software was written, is not oriented towards numerical calculations, thus slowing down when going through the updating process (to related

spreadsheets) following the change in a budget line number. The response times will appear somewhat slow relative to a standard spreadsheet. Since only one participant mentioned the response time, we don't expect this to be a major problem in either further studies in our lab or in network use of Timbuktu. As noted in an earlier section, the Remote Timbuktu, will seem quite slow compared to the network version. This problem is exacerbated when the Remote Computer is linked to a network through a relay computer.

6. Recommendations

Technical Considerations for Computer Supported Distributed Team Work

From our experience we found that a designer of a Distributed Group Decision Support System (DGDSS) must pay attention to several issues. We emphasize the fact that the setting envisioned in our research calls for interfacing different systems which gives rise to additional considerations in software design. The main points to be considered are:

1) **Transmission Speed:** For the purposes of sharing of screens, we used the Timbuktu software. If modems and the "remote" version of the software are to be used, we recommend that at least 9600 bps modems be used. Though we did use slower modems, the response times are not tolerable. We do note that even 9600 bps modems are not satisfactory for sending bit mapped graphics.

   LocalTalk / PhoneNet local area networks give reasonable response times; however, the load on the network imposed by other users must be taken into account. The current version of Timbuktu does not support color. If it were to support color we expect that a speedup factor of 8 at least in transmission speed will be called for since the Macintosh uses 8 bits to store color. This is under the assumption that the hypothetical new version maintains a copy of the color lookup table at the guest computer also.

2) **Color:** The budgeting and other software should be designed in black and white mode; else, it should be designed so that the user could turn it to black and white mode when necessary. This restriction is imposed by the Timbuktu software used for screen sharing/control of another Macintosh. Timbuktu transmits only the black and white version of the screen. When the monitor is set to display color, the substitution of black and white for various colors could render the transmitted copy difficult, even impossible, to interpret.

3) **Screen Size :** While designing the budgeting and other software, one should remember that the guest (observer) may not have a large Mac II type screen. This implies that every member of the group should have the same screen size or the software must be designed for the smallest (Macintosh Plus) screen size. The first condition is hard to achieve in a diverse organization. The second condition may not be a good solution either, since the budgeting software is expected to be used most of the time by a single user, and it may be inefficient not to fully utilize the larger screen. A possible solution could be to use a commercially available control panel software called "Stepping Out II", which permits a Macintosh with a small screen to view various portions of the larger screen (a facsimile of the larger screen is maintained in memory). If one were to use this strategy, attention must be paid to the memory availability. A better solution may lie in designing the budgeting software so that the host can move and/or resize the windows of the software, before the screen sharing session begins, so that the relevant portion of the screen could be observed by the guest.

4) **Compatibility of Memory Resident Programs :** During our experiments, we found that the operating systems crashed more often than we expected. We felt that this could be due to various memory resident programs such as Desk Accessories (DA) on the Macintosh and

Terminate and Stay Resident (TSR) programs on IBM PS/2. We eventually decided to remove all such programs except for the bare essentials like the Control Panel on the Macintosh. Though this compatibility problem could exist even when dealing with a single isolated workstation, it manifests itself as a major problem in DGDSS context since one has to worry about collaboration (screen sharing, control of other computers) between members with arbitrary configurations of hardware, software and peripherals.

5) **Autosave :** Since systems may crash, we found the autosave feature of SuperCard to be very useful. As many individuals are working concurrently on unstructured tasks, periodic save features could prove very useful.

6) **Privacy/Security Considerations :** Most of all we felt that Timbuktu does not do a satisfactory job in alerting the host when his/her computer is being observed or controlled by a guest. It does put a small icon (a face to indicate being observed and a hand on a mouse to indicate being controlled) on the top right hand corner of the screen. However, it does not alert the host with some sound (say a beep) or an alert dialog box at the beginning of a Timbuktu session. Nor does it inform you as to when additional visitors check in. We strongly recommend incorporating permission seeking mechanisms and/or alert features. In session #4 we found that Region 2 was observed without its knowledge!

Computerization has made it easy to navigate through a large volume of information rather quickly. But this has a drawback especially during collaborative sessions. The observer may easily stumble upon some sensitive classified information that he/she is not supposed to see. The host should learn to, better yet, should be facilitated to quickly reconfigure the large volume of stored information, prior to starting a Timbuktu session, so that such security/privacy problem are avoided/minimized.

Social Considerations for Computer-Supported Distributed Team Work

Although computer-supported distributed team work is technically feasible, and in some cases easy to implement, its successful use may ultimately depend on the manner in which such information technology is incorporated into the flow of group work. To the extent that such information technology is smoothly integrated into an organization with appropriate training and participant understanding, then distributed teams should be able to reap the benefits that such technology permits while avoiding those situations in which such group configurations may be inadequate for effective performance.

The screen sharing capability that was implemented in the distributed groups we studied offers an example of how the technical capability to screen share may not be initially recognized as useful for task performance. As we noted earlier, our experimental groups did not utilized the screen sharing capability at any great rate. In part, this lack of use can be traced to their relative unfamiliarity with how to use it, in spite of the brief training session that we had conducted. Clearly, the simple demonstration we gave of the Timbuktu screen sharing capabilities was not enough to develop a sufficient level of understanding and comfort with the technique. It would appear that any information technology that involves a substantial change in the "normal procedure" of group work will require enough training to remove the "strangeness" associated with working in such a fashion.

Another problem that can emerge with screen sharing capabilities concerns the appropriate guidelines and norms that develop concerning the exchange of information in this fashion. The experimental groups we examined were "normless" in this sense, which may have contributed to the hesitation to use the screen sharing capabilities that we observed (i.e., is it appropriate for me to peek in on someone else). This lack of norms was especially problematic for one of the experimental groups where two of the regional managers were observing the third without his

being aware that he was being observed. In this case, neither of the observing regional managers had asked for permission to observe; they simply invoked Timbuktu and started observing. The observed manager continued to go through his project information without regard to the presence of others. Clearly, this kind of situation can lead to a great deal of discomfort with screen sharing. Without the active development of appropriate norms concerning when and where it is appropriate to use such capabilities, screen sharing (and its ability to convey visual task information) may not be fully utilized. This situation also suggests quite strongly that software developers (like Farallon) should make a greater effort to ensure that observed individuals know when and if they are being observed.

Although we were not able to directly investigate the issue, another behavioral issue that may impact the effectiveness of distributed team work concerns group development. That is, do the distributed members develop working relationships with other distributed group members that are different in character than those in face-to-face groups. For example, is there less cohesiveness among distributed group members? Is it easier to ignore the requests of a distributed group member? Does this, in turn, translate into less of a commitment to the organization as a whole? Some of our observations of our experimental groups lead us to be concerned about this issue. In particular, watching the two regional managers covertly observing the third and the comments they made to themselves about the others lead us to believe that the lessened social presence of others may serve to loosen normative guidelines about appropriate behavior. Flaming in E-mail exchanges is another example of this type of behavior. What impact this may have on the development of member relationships and subsequently on group productivity is the empirical question of interest.

Further Experimentation into Computer-Supported Distributed Team Work

Further experimentation on computer-supported distributed teamwork is needed. Our first concern in this section will be on further refinements of the experimental procedure we developed and some extensions of it. The next concern will be a broader one, encompassing some broader issues that should be studied in the general area of computer-supported distributed teamwork.

Our current experimental procedure was designed to simulate a task relevant to USAISC. The information needed to solve the basic budget-cutting task was heavily loaded with quantitative data. As initially designed, the task appeared to make high demands on the individuals as individuals as opposed to group members (e.g. learning about the nature of the projects). We had initially envisioned that by using the basic budgeting task and creating a scenario that was both technically and socially complex, we would set the stage for group work that would benefit from the "visual channel" provided by Timbuktu. This did not happen to the extent we had anticipated.

Our explanations for why this didn't happen also happen to suggest what should be done to alter the experimental procedure. First, the task was complex, not only at the group level, but also at the individual level. Individuals had to both learn how to use the software as well as learn about 5 projects. We would recommend three tactics for reducing the effect of this individual level complexity. First, provide an initial training session whereby individuals could become facile with the software as well as getting used to the budget cutting scenario. Second, provide all background information about projects on an *a priori* basis, so the subjects do not have to discover the information while performing the task. Third, reduce the number of projects per person from 5 to 3. We think that these changes would lead to more time to share information and work out group issues rather than individual issues.

A second area that needs work is the creation of intermember conflict. Ideally, we wanted the group task to one of negotiation and compromise, not simply sharing information. One of the points that we had hoped would be debated, was how much of a cut each member should strive for. We had intentionally stacked the priority list to suggest the Region 3 manager should take

larger cuts. Most groups apparently adopted a norm that each person should take equal cuts. This norm wasn't explicitly discussed, but rather was assumed by the members based on personal standards of what would be fair. We would recommend stacking the deck in a different manner. Specifically, we suggest that the regional managers begin with different amounts of budget allocations. Rather than each being in charge of 2.5 million dollars, have one person in charge of 3.5 million and the other two in charge of 2.0 million. This should cause more discussion of a group strategy for allocating cuts.

Development of Alternative Tasks

One might ask whether the budget-cutting task is the type of task where computer screen sharing will be of much advantage. Because the information is primarily numerical, this information can be communicated accurately by voice. That is, person A can tell person B that he/she has cut 3 engineering positions from a budget resulting in a savings of $145,000 dollars. Not much is gained by demonstrating this on the screen, except to the extent that the observers may see some other numbers on the screen that might cause them to question person A's action.

Tasks that have a stronger requirement of a visual component would obviously benefit more from screen sharing. For instance, suppose that a team of architects has a set of preliminary drawings that it wishes to discuss. The drawings are digitized (or initially created through computer software). It should be beneficial for a person to explain their ideas by using both phone communication and using the cursor to point out various features on their drawing. There are many other examples of similar tasks where seeing as well as listening is critical. For example, advertising groups working on logos, magazine layout, billboards, and so on would be likely candidates.

We should note that many of the suggested changes can be relatively easily incorporated within the framework of the budgeting task software and scenario that was developed for the current research. In fact, SuperCard was selected as the development tool expressly for the purpose of providing revision flexibility.

Future Research on Computer-Supported Distributed Team Work

As we successfully address the technological problems of linking groups electronically, we should begin looking for ways to better manage our applications of hardware and software. Any such attempts at managing this process will have to be based on a clear understanding of: 1)group performance issues in general, and 2)the dynamics of computer-supported distributed groups in particular. At this point in time, most of the attention has been focused on the technical aspects. We are not generating the knowledge concerning the dynamics of distributed groups which will serve us in creating or shaping such groups, improving our management of them, or designing performance-improving interventions. There exists a need to begin a bridging process which will translate what we know about interacting groups and test its applicability to distributed groups, identifying commonalities where generalizations can safely be made, as well as limitations or process aberrations which need to be noted and accounted for.

Long-term, it is proposed that a program of research be continued which examines similarities and differences between computer-supported distributed groups and face-to-face groups along the major, basic group process dimensions such as communication, motivation, influence, group development, and leadership. Such a program should identify group task contingencies which affect the impact of these dimensions on the performance of different kinds of computer-supported groups. For example, certain group process factors may operate differently for groups engaged in information synthesis tasks, conflict resolution tasks, creativity tasks, etc. Finally, such a research program would study performance-enhancing interventions which would

identify technical and managerial means for facilitating computer-supported processes and/or minimizing dysfunctional forces.

For example, we know that communications aimed at a group member expressing a deviant position (e.g., counter to the prevailing group norm) will increase immediately after the expression of such a position, and will vary as a function of the group's assessment of his/her likelihood of changing. The success of such group influence attempts is obviously related to the reward and sanction power the group has over the individual. One might argue that since the deviation from the group norm could be as apparent in the computer-supported distributed group as in the face-to-face group, the changes in communication patterns to the target person ought to be replicated in computer-supported groups. However, to the degree that interacting groups are part of the immediate environment for the deviant, being more readily able to express displeasure, use non-verbal cues, and even ostracize such a member, one might argue that such groups will be more effective than computer-supported groups in obtaining conformity.

In closing, it is becoming common for Management Information Systems researchers and "groupware" software development people to talk about a software "toolbox" from which users can choose programs and modules that will help them with a particular individual or group task. We are suggesting that the distribution of group members can quite likely change the fundamental nature of group processes and hence software toolboxes which are partly responsible for the change certainly don't address the consequences of the change. Therefore, group management or intervention strategies may eventually be needed in conjunction with computer-supported distributed groups. These recommendations may pertain to modifications in the computer-supported work environment, supplementary group development efforts before or during group performance episodes, or observational guides for identifying dysfunctional group events. These strategies should be based on the results of empirical studies.

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Table 1
Summary Budget Results for All Regions Across All Sessions

Session 1 Summary

Region 1

	Initial	Revised	%Cut
A1000	710	577	18.7
A2000	595	585	1.7
A3000	580	485	16.4
A4000	415	315	24.1
A5000	210	200	4.8
Total	2510	2162	13.9

Region 2

	Initial	Revised	%Cut
B1000	430	388	9.8
B2000	822	352	57.2
B3000	375	365	2.7
B4000	563	456	19.0
B5000	310	286	7.7
Total	2500	1847	26.1

Region 3

	Initial	Revised	%Cut
C1000	265	265	0.0
C2000	922	922	0.0
C3000	628	628	0.0
C4000	140	73	47.9
C5000	545	0	100.0
Total	2500	1888	24.5

Reg1 Totals 7510 5897 21.5

Session 2 Summary

Region 1

	Initial	Revised	%Cut
A1000	710	710	0.0
A2000	595	545	8.4
A3000	580	0	100.0
A4000	415	415	0.0
A5000	210	0	100.0
Total	2510	1670	33.5

Region 2

	Initial	Revised	%Cut
B1000	430	345	19.8
B2000	822	642	21.9
B3000	375	330	12.0
B4000	563	406	27.9
B5000	310	310	0.0
Total	2500	2033	18.7

Region 3

	Initial	Revised	%Cut
C1000	265	263	0.8
C2000	922	922	0.0
C3000	628	628	0.0
C4000	140	113	19.3
C5000	545	0	100.0
Total	2500	1926	23.0

Reg2 Totals 7510 5629 25.0

Table 1 cont.

Session 3 Summary

Region 1

	Initial	Revised	%Cut
A1000	710	505	28.9
A2000	595	361	39.3
A3000	580	451	22.2
A4000	415	320	22.9
A5000	210	200	4.8
Total	2510	1837	26.8

Region 2

	Initial	Revised	%Cut
B1000	430	240	44.2
B2000	822	470	42.8
B3000	375	265	29.3
B4000	563	451	19.9
B5000	310	274	11.6
Total	2500	1700	32.0

Region 3

	Initial	Revised	%Cut
C1000	265	233	12.1
C2000	922	742	19.5
C3000	628	535	14.8
C4000	140	99	29.3
C5000	545	342	37.2
Total	2500	1951	22.0

Reg3 Totals 7510 5488 26.9

Session 4 Summary

Region 1

	Initial	Revised	%Cut
A1000	710	685	3.5
A2000	595	537	9.7
A3000	580	580	0.0
A4000	415	415	0.0
A5000	210	210	0.0
Total	2510	2427	3.3

Region 2

	Initial	Revised	%Cut
B1000	430	305	29.1
B2000	822	822	0.0
B3000	375	375	0.0
B4000	563	563	0.0
B5000	310	310	0.0
Total	2500	2375	5.0

Region 3

	Initial	Revised	%Cut
C1000	265	235	11.3
C2000	922	922	0.0
C3000	628	628	0.0
C4000	140	0	100.0
C5000	545	340	37.6
Total	2500	2125	15.0

Reg4 Totals 7510 6927 7.8

Table 2
Multiple Regressions for Modeling Budget-Cutting Process

		Beta Weights				
	R^2	Initial Budget	Organizational Priority	Number of Self Priority	Number of Projects that Depend on It	Projects it Depended On
Sessions 1-3	.14	.14	.32	.39	-.06	.22
Session 1	.47	.32	.65	.75	-.11	.26
Session 2	.05	-.09	.05	.18	-.06	.12
Session 3	.60	.55	.58	.50	-.01	.56
Session 4	.80	-.30	.66	.62	.37	.38

Table 3
Summary of Project and Budget Line Item Accesses

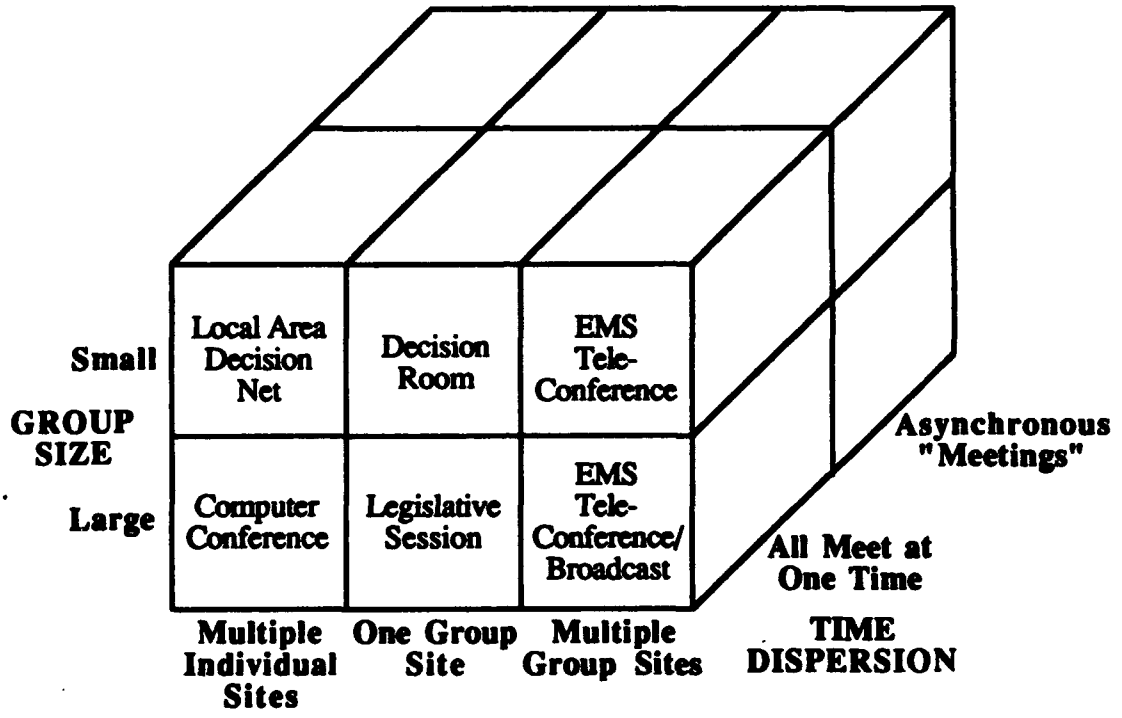
	Number of Project Accesses	Number of Line Item Accesses
Session 1		
Region 1	25	54
Region 2[a]	12	9
Region 3	22	13
Mean	*19.7*	*25.3*
Session 2		
Region 1	16	15
Region 2[b]	2	4
Region 3	15	17
Mean	*11*	*12*
Session 3		
Region 1	17	56
Region 2	31	78
Region 3	36	66
Mean	*28*	*66.7*
Session 4		
Region 1	23	43
Region 2	8	7
Region 3[c]	6	15
Mean	*12.3*	*21.7*

[a]Lost 43 minutes of work due to crash.

[b]Lost 50 minutes of work due to crash.

[c]Lost 64 minutes of work due to crash.

Figure 1
Taxonomy of GDSS Environments
(from Dennis, et. al., 1988)



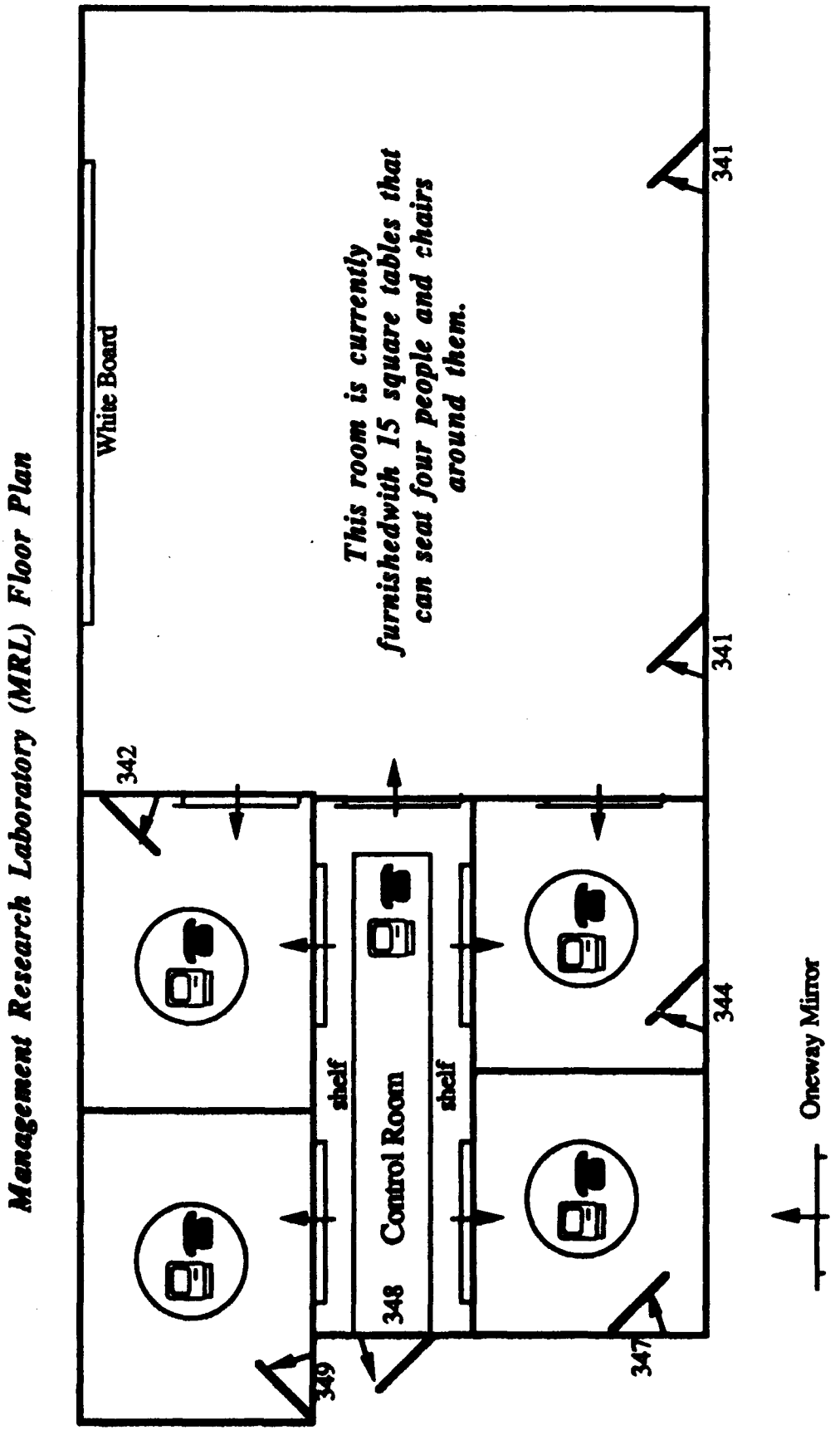
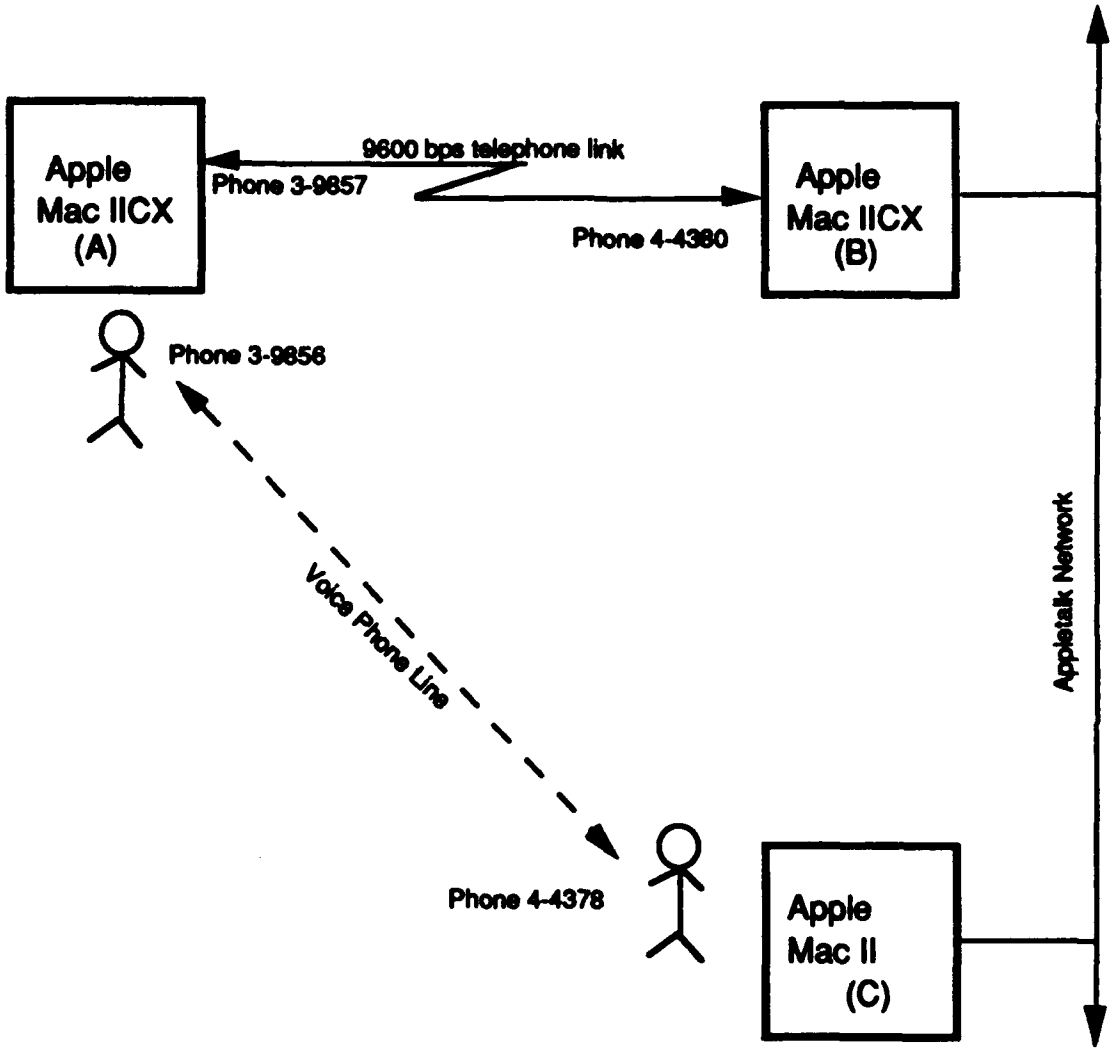


Figure 1
College of Management Behavioral Research Laboratory Floor Plan

Figure 3
Illustration of a Distributed, Interacting, Screen Sharing Team Configuration with Remote (dial-in) Member (Network and Remote Timbuktu)



Appendix A
Omega Project Priorities and Classified Information for All Regions

OMEGA INCORPORATED
New R&D Project Priority List

REGION 1

Project #	Priority	Title
A1000	3	MPED Records Maintenance
A2000	9	IPO Micrographics
A3000	8	Voice Activated Computer Communications
A4000	11	Optical Digitizer Analyzer
A5000	1	LPID Display

REGION 2

Project #	Priority	Title
B1000	13	Prototype High Speed CPU-Link
B2000	4	Large Scale Switching Software
B3000	7	Enhanced Air Traffic Control System
B4000	6	Scheduling and Reservations Software
B5000	2	Credit Reporting Software

REGION 3

Project #	Priority	Title
C1000	14	Satellite Relay Project
C2000	5	Fiber Optic Enhancement
C3000	12	VOC Visual Transmitter
C4000	10	Network of the Future
C5000	15	Radio/Telephone Computer Communications

OMEGA INCORPORATED
Region 1--Classified Information

Project A1000- MPED Records Maintenance

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 3/15 Your Region Priority-- 4/5

This work is one of the outcomes of several strategic planning sessions concerning how the MPED division could cut costs and run a more competitive, leaner operation.

PERSONNEL
Personnel for this project consists of system analysts, programmers and clerical assistance.

Two of the full time programmers are critical to the development of this project in that they bring special skills that are hard to replace.

Two of the half time programmers are also critical to this project. In addition to being hired specifically to work on this project their time is also being shared on project # C4000.

The overtime allocation represents a government requirement that personnel budgets reflect an anticipated overtime pay allocation, even though project members are encouraged to take comp time. Past experience has suggested that about 50% of this money is not spent.

The temporary hire reflects the hire-back of a government retiree that used to work in a particular office. She had special knowledge relative to the record maintenance project and thus was hired back even though she "retired" after 30 years in government service.

The part time assistants are usually hired from the local college. They sometimes become full time employees after graduation. They work about 20 hours per week to do some support work for the programmers.

EQUIPMENT

Workstations, the networking hardware is of no immediate use.

The Superscreen Displays are very important to the project. Although it is possible to use the Superscreen displays without the Node-Masters, it is difficult to get good test results for purposes of determining auxiliary requirements.

The SuperAccess Bit Accelerator is not necessarily needed for this project. When this project is implemented, the accelerators would be available due to a central purchase. However, another project, C5000, desperately needed the accelerator for its progress, but did not have funding. You were able to justify slipping it into your project budget.

Project A2000- IPO Micrographics

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 9/15 Your Region Priority-- 1/5

This project depends on the completion of project A1000.

PERSONNEL
Need everybody on board to complete this work in time to feed into project A1000.

EQUIPMENT
Analyzer scopes are absolutely necessary. Work stations are discretionary.

MATERIAL & SUPPLIES
Technical hardware should not be touched. Office supplies are cuttable.

TRAVEL
Site travel is high priority. Headquarters travel is second priority. Conference travel is low priority.

SUBCONTRACTOR
Subcontractor is being used for the first time with projects under your management. Their work is on some R&D type work which would be an enhancement to the basic mission.

Project A3000- Voice Activated Computer Communication

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 8/15 Your Region Priority-- 2/5

This project is moving some basic research close to commercial applications. It probably would be used in both Projects B3000 (Enhanced Air Traffic Control Systems) and B4000 (Scheduling and Reservation Systems).

EQUIPMENT
The computers and telephones are general replacement items. The voice recognition modules are essential.

Project A4000- Optical Digitizer Analyzer

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 11/15 Your Region Priority-- 3/5

This project is actually the completion of work that has been going on for 4 years. Although it has a different project number than before, it is really continuation money. To drop this project at this point would mean that 4 years worth of progress would be virtually lost and the key employees would leave (the engineers).

Project A5000- LPID Display

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 1/15 Your Region Priority-- 5/5

This project represents fundamental research by one of the most highly respected computer scientists in the world (who work for Illini Systems). Though this project does not have any immediate commercial implications, it may eventually provide the basis for a much better visual display on large systems. Specifically, another project, B3000 (enhanced air traffic control system) is expected to use some of the developments from this project.

PERSONNEL
Because most work is being done by contractor, cuts in ancillary personnel (non professional) are ok.

EQUIPMENT
Supercomputer time is absolutely essential.

OMEGA INCORPORATED
Region 2--Classified Information

Project Project B1000- Prototype High Speed CPU-Link

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 13/15 Your Region Priority-- 3/5

This project has been heavily supported in the past by vice-presidents in your company. Although the total amount of money is rather small, the payoff if it is successful could be tremendous.

PERSONNEL
Full time engineers should not be cut. This project was used to hire top notch people. In addition, consultant is very important to project.

TRAVEL
Consultant travel can obviously be cut if consultant is cut.

Project Project B2000- Large Scale Switching Software

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 4/15 Your Region Priority-- 5/5

The project has several justifications. First, even though it has a primary market in the commercial arena, it also has potential payoffs for some other internal projects (e.g., Project C1000).

PERSONNEL
The 4 full time programmers demonstrate different talents. To lose any of them would mean that it would be difficult to meet project deadlines.

EQUIPMENT
The work stations are not absolutely necessary but do represent a further modernization of the labs equipment. High level PC's and memory upgrade are essential to project.

SUBCONTRACTORS
QuickSys, Inc. has been know to overrun its budget. They do excellent, innovative work which is irreplaceable, but past experience suggests that they will ask for an extension in time and money.

Project Project B3000- Enhanced Air Traffic Control System

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 7/15 Your Region Priority-- 2/5

PERSONNEL
Technical assistant are typically college students. For this type of work, they are frequently laid off when budgets are tight.

EQUIPMENT
The enhanced PC's are part of a general effort to upgrade equipment.

SUBCONTRACTORS
Illini Systems, Inc. has become a preferred subcontractor since they were recently granted Minority Business status.

Project Project B4000- Scheduling and Reservation Software

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 6/15 Your Region Priority-- 1/5

This project must move forward if it is to be worth anything. There are competitors working on similar projects.

PERSONNEL
Lead programmer position is less important than the other professional positions.

EQUIPMENT
Enhanced PC's will be necessary on this project although it is possible to borrow from other projects. Having dedicated PC's increases productivity.

SUBCONTRACTORS
The subcontractor work is not vital because they are working on a feature that is probably several years away from viability. However, a member of your Board of Directors is a large shareholder in LOL Systems, Inc.

Project Project B5000- Credit Reporting Software

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 2/15 Your Region Priority-- 4/5

PERSONNEL
All personnel and overtime are essential for monitoring work of subcontractor.

EQUIPMENT
Enhanced PC is discretionary and replacement equipment.

SUBCONTRACTORS
All work on this project is being conducted by the subcontractor.

OMEGA INCORPORATED
Region 3--Classified Information

Project C1000- Satellite Relay

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 14/15 Your Region Priority-- 2/5

This project will also be used in Project C5000 which is the Radio/Telephone Communication Project.

Project C2000- Fiber Optic Enhancement

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 5/15 Your Region Priority-- 4/5

This project is extremely important to your company. If progress is made in this area, it might mean your company will have the competitive edge on fiber optic transmission for years to come. This is expected to be a multi-year project.

This project is also expected to have an impact on C4000 which is "Network of the Future" as well as project A3000 which is "Voice Activated Computer Communications".

PERSONNEL
The personnel are expected to be hand-picked experts from all over the company.

About half of technical assistant positions would go to college students. The other half would go to experienced technicians who would be more important to the progress of the project.

EQUIPMENT
This remains an unspecified expenditure. In the past, such a large unspecified expenditures would contain 40-60% replacement equipment.

MATERIALS & SUPPLIES
Technical hardware should not be touched. Office supplies are cuttable.

Project C3000- VOC Visual Transmitter

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 12/15 Your Region Priority-- 1/5

Once the commercial transmission lines change over to higher grade media, the VOC Visual transmitter will be obsolete. This project has been authorized for funding for the past 5 years. It has always been cut before the money was actually allocated. A rationale for this project is that Project B1000 will require such high speed transmission.

PERSONNEL
These positions have not yet been filled. In fact, the Subcontractor was going to be hired first and then a project team established that was compatible with the subcontractor.

EQUIPMENT
All of this equipment is necessary if any progress is to be made on this project. The miscellaneous electronics are a general category that might represent non-critical expenditures.

MATERIALS & SUPPLIES
High density cable is not typically available unless it is special ordered for a project.

SUBCONTRACTORS
LOL Contractors tends to employ some of the recent retirees from your company.

Project C4000- Network of the Future

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 10/15 Your Region Priority-- 5/5

This project is supposed to result in a better understanding of what the marketplace wants in computer network features. Specifically, it is supposed to prepare reports that will be somewhat useful in Projects B5000 (Credit Bureau) and B4000 (Scheduling and Reservations). The project group is a unique collection of engineers and marketing specialists who are knowledgeable about clients. There should be suggestions concerning what niches of the market this company can fill in the next decade. In part, these niches will depend on some outcomes of R & D projects which are on-going in this company.

PERSONNEL
Market researchers tend to be professors and graduate students from a local university. The pay for engineers would not result in hiring any new people, but rather be "sabbatical-type" pay for some older employees.

TRAVEL
Without knowing who the personnel will be, it is hard to determine how much travel will actually be necessary.

Project C5000- Radio/Telephone Computer Communications

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 15/15 Your Region Priority-- 3/5

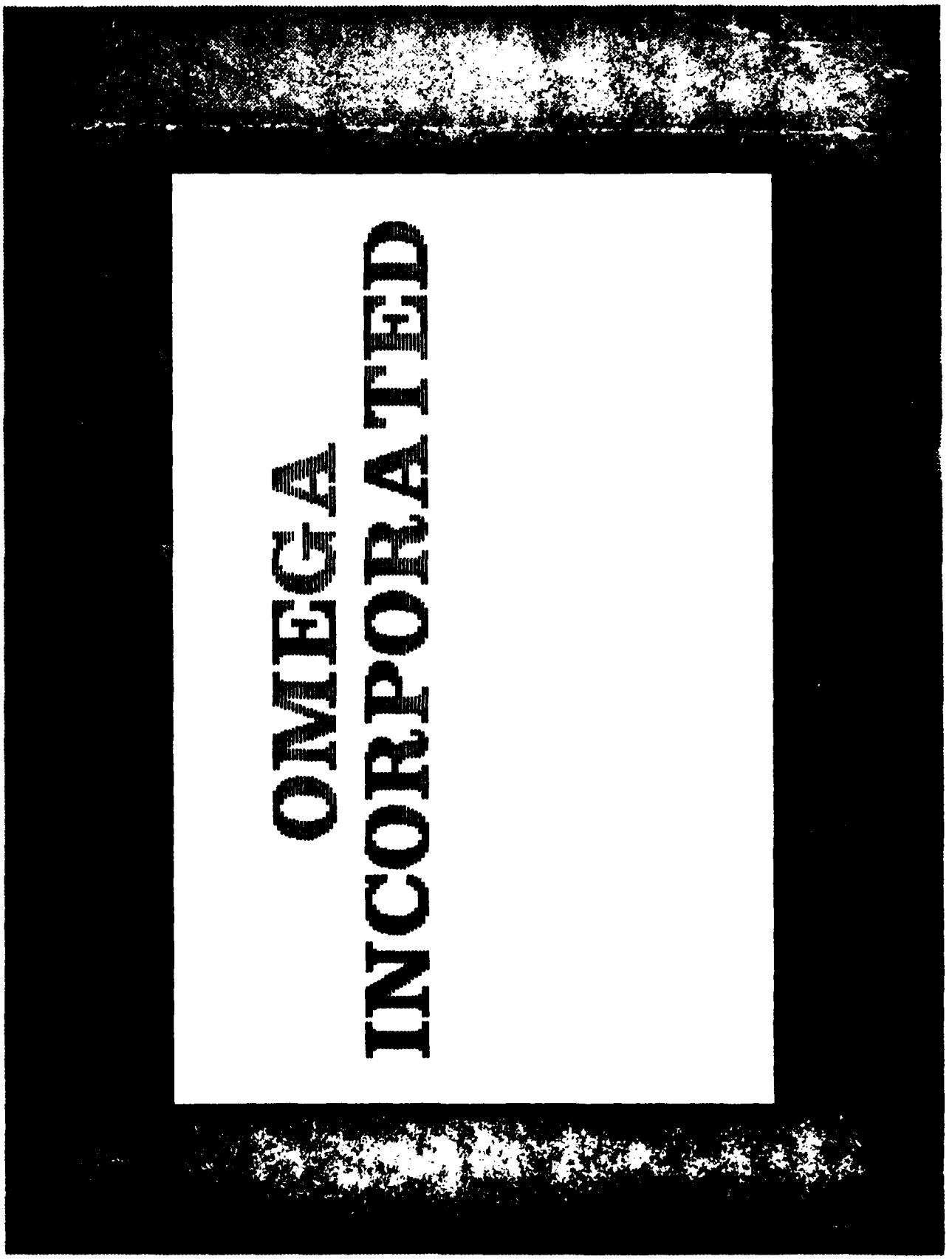
This project has been suggested for several years, but has never been funded. This is probably the final year that this project will be worthwhile (because of anticipated progress of competitors).

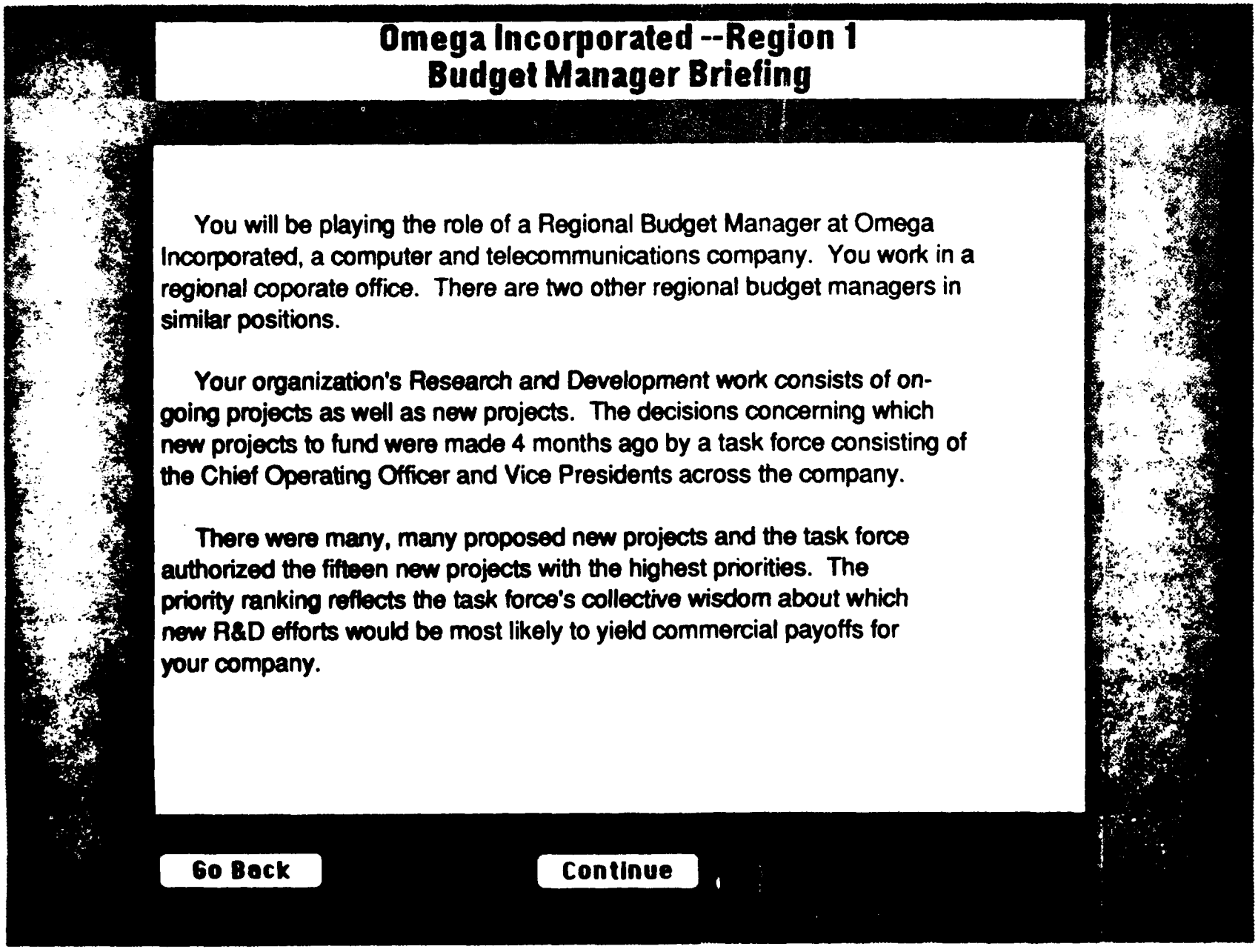
PERSONNEL
The engineers picked to work on this project are all top rate people. If this project is cut, you would probably lose them.

The technical assistants are college students who are actually on internship and are not critical to project success.

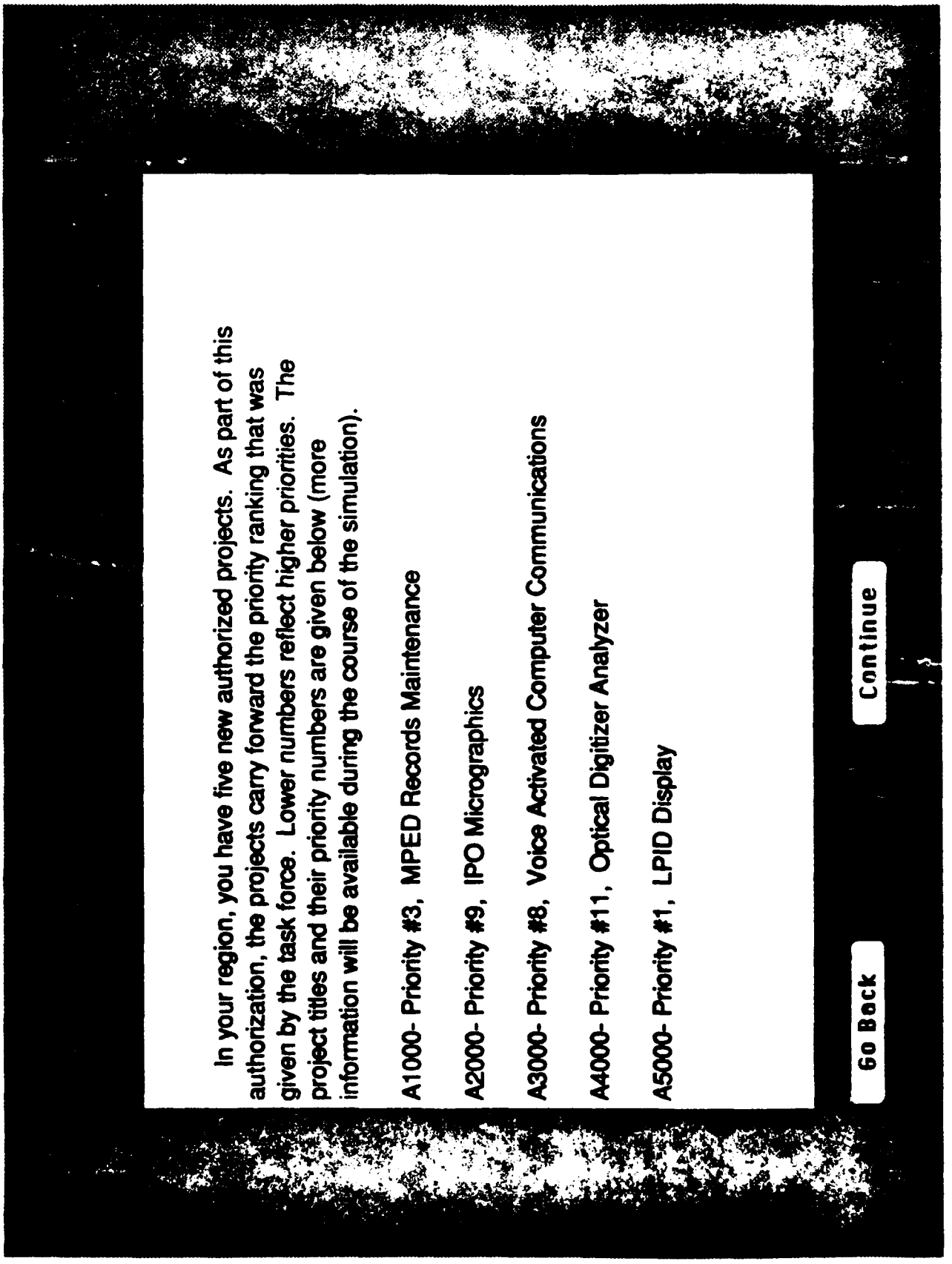
EQUIPMENT
Computers are replacement equipment but would be seen as perks for the engineers working on the project. The modular radios are critical to the success of the project.

Appendix B- Screen 1
Task and Scenario Introduction Screen Displays

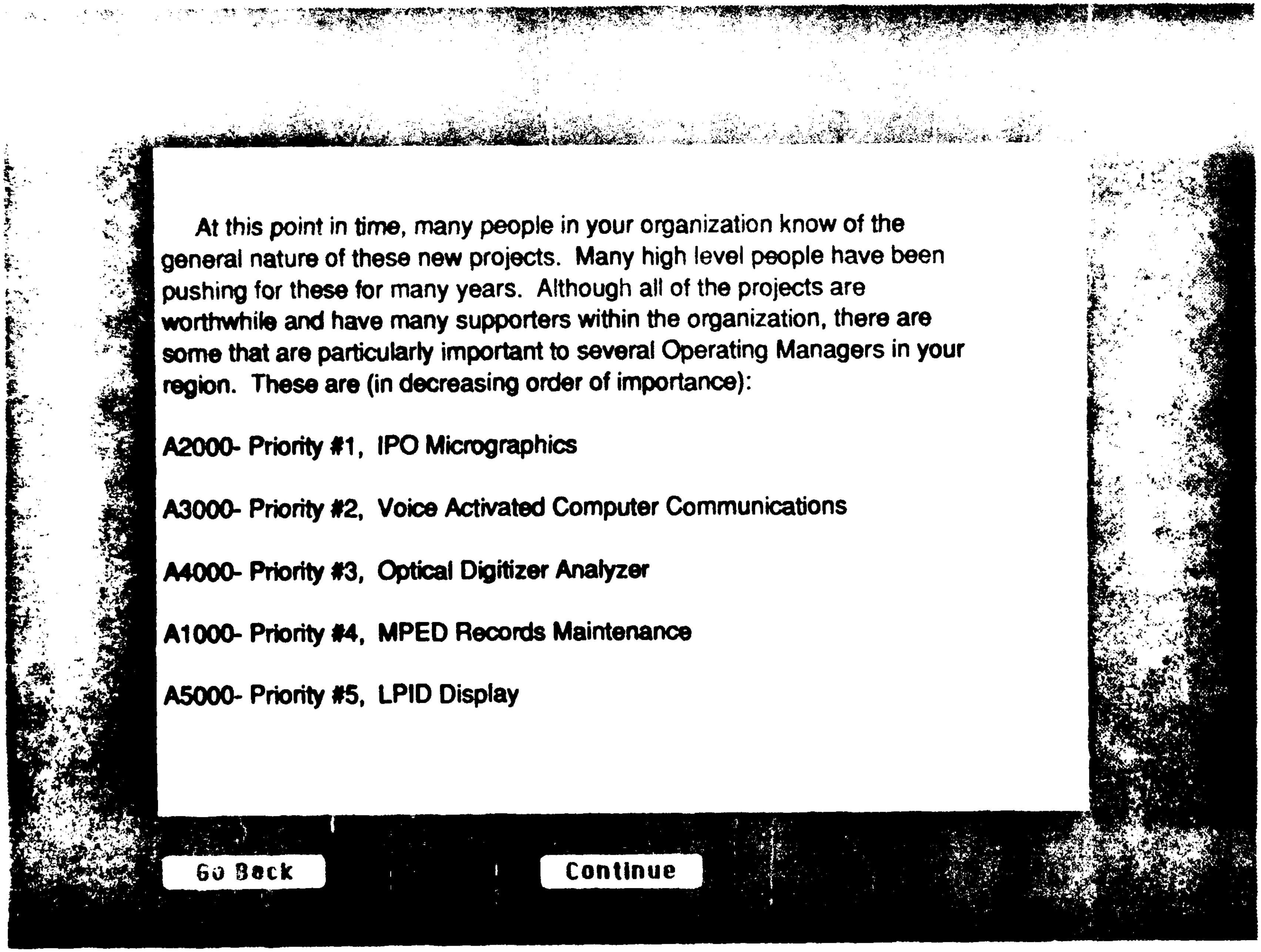



Omega Incorporated --Region 1
Budget Manager Briefing
You will be playing the role of a Regional Budget Manager at Omega Incorporated, a computer and telecommunications company. You work in a regional coporate office. There are two other regional budget managers in similar positions.
Your organization's Research and Development work consists of on-going projects as well as new projects. The decisions concerning which new projects to fund were made 4 months ago by a task force consisting of the Chief Operating Officer and Vice Presidents across the company.
There were many, many proposed new projects and the task force authorized the fifteen new projects with the highest priorities. The priority ranking reflects the task force's collective wisdom about which new R&D efforts would be most likely to yield commercial payoffs for your company.
Go Back
Continue

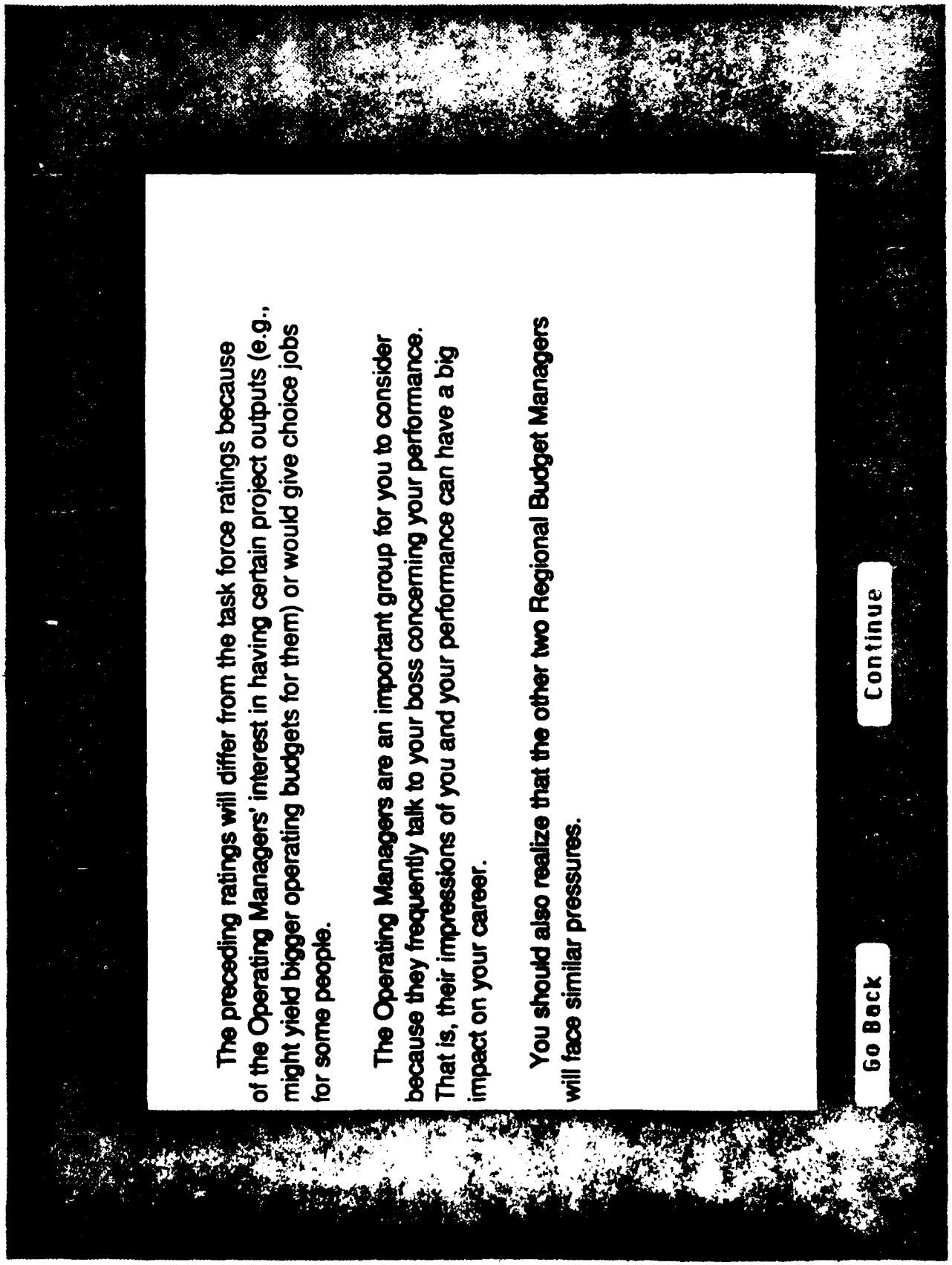
Appendix B- Screen 3



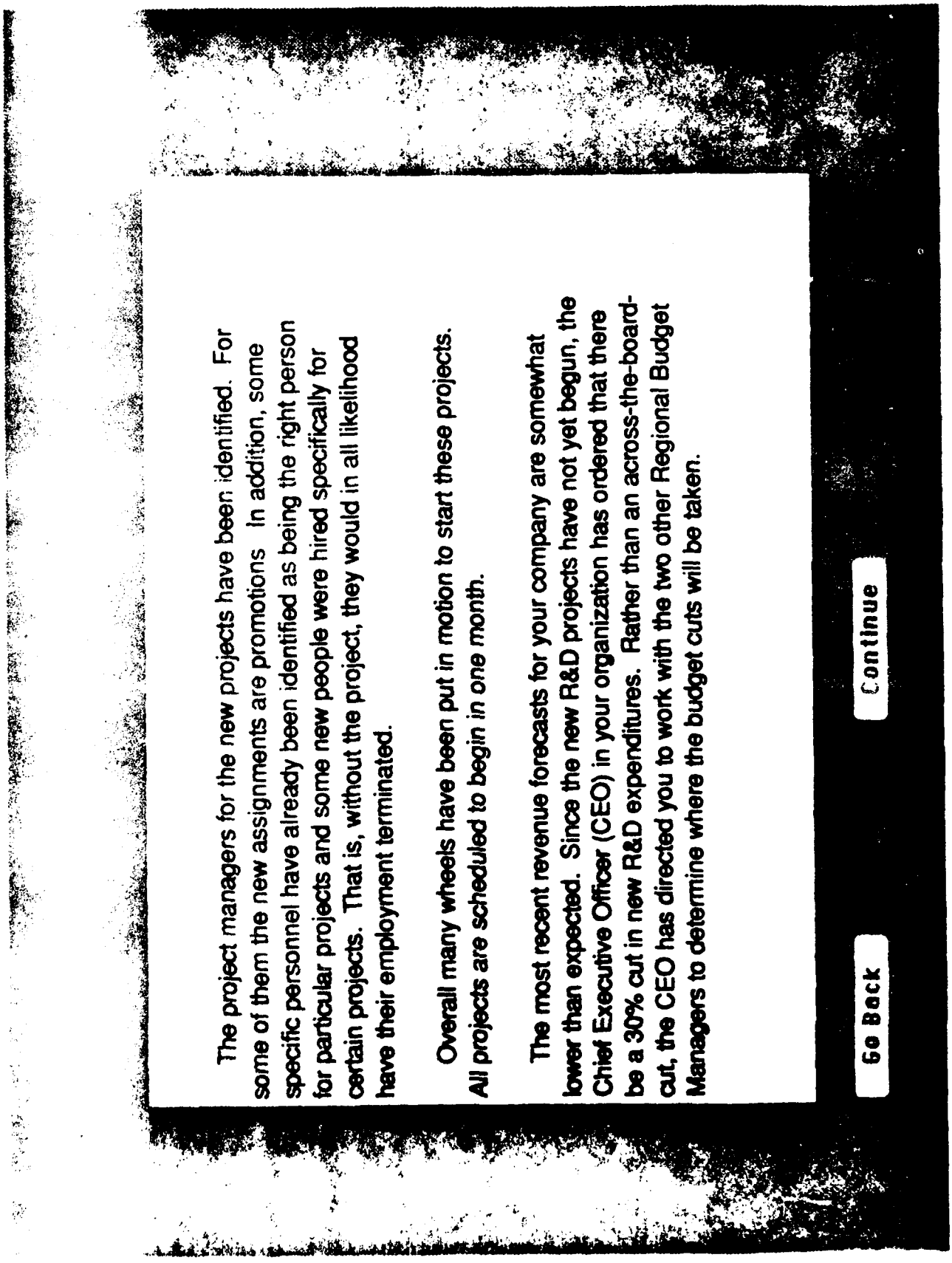
Appendix B- Screen 4



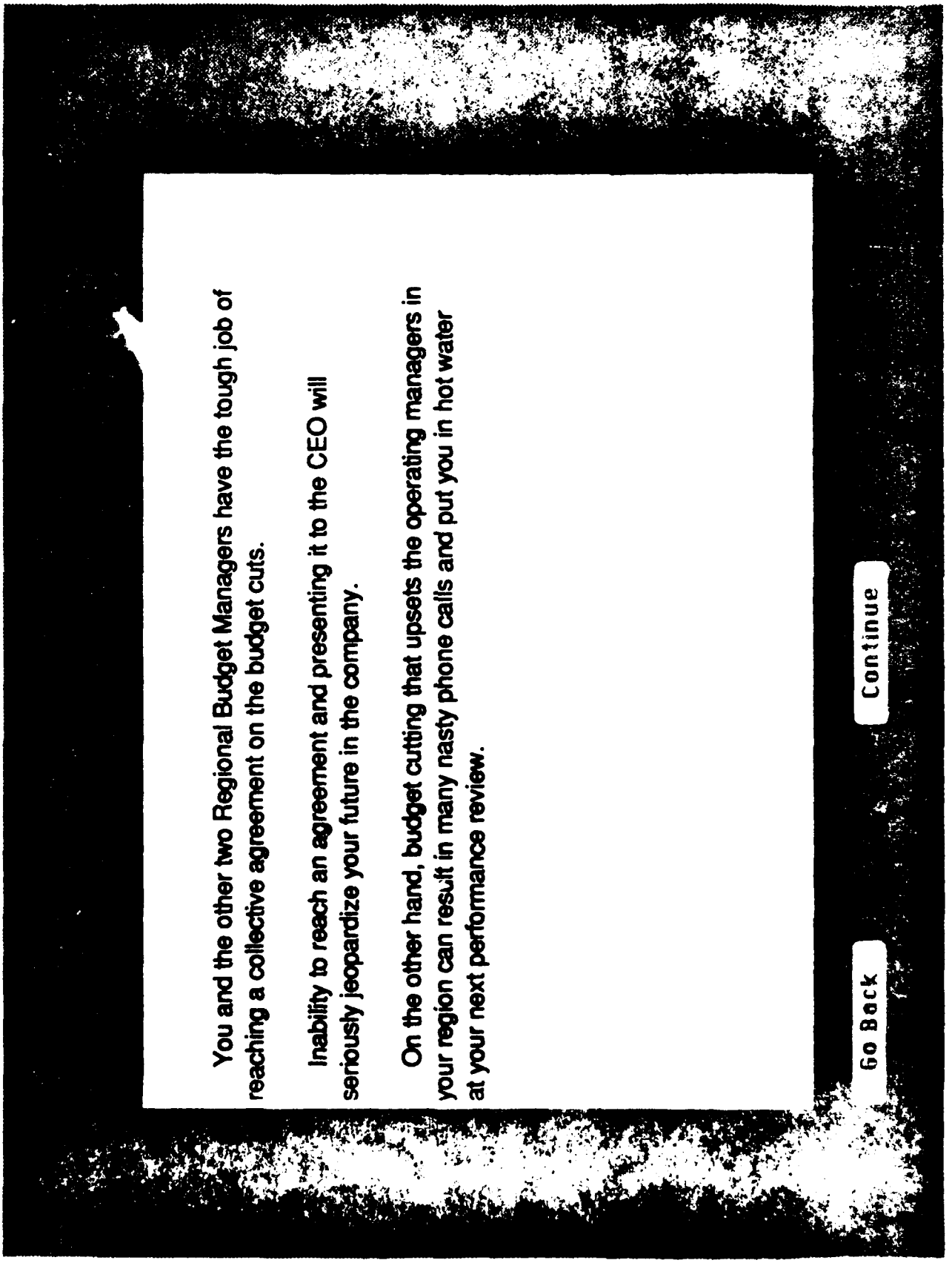
Appendix B- Screen 5

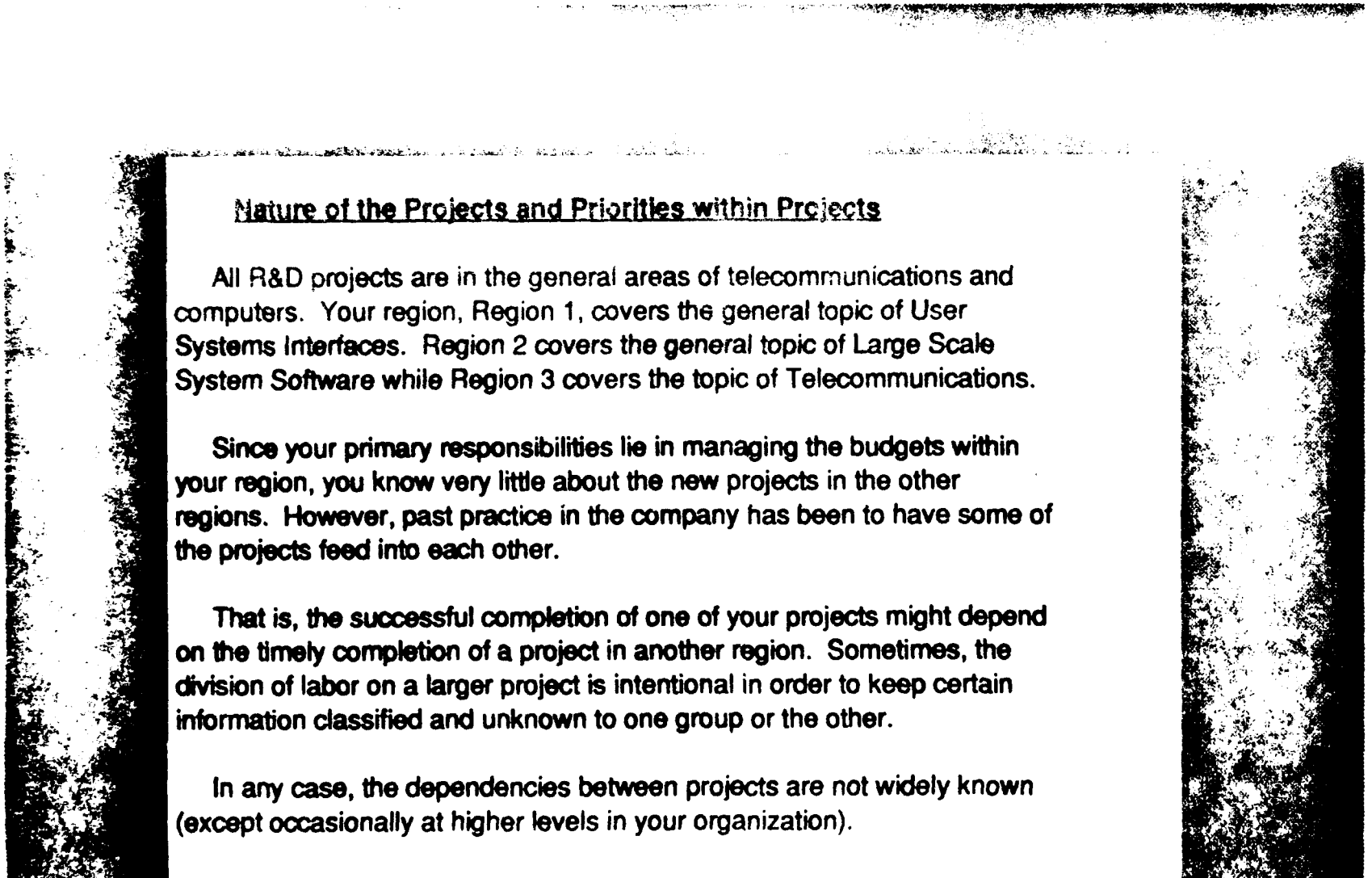


Appendix B- Screen 6

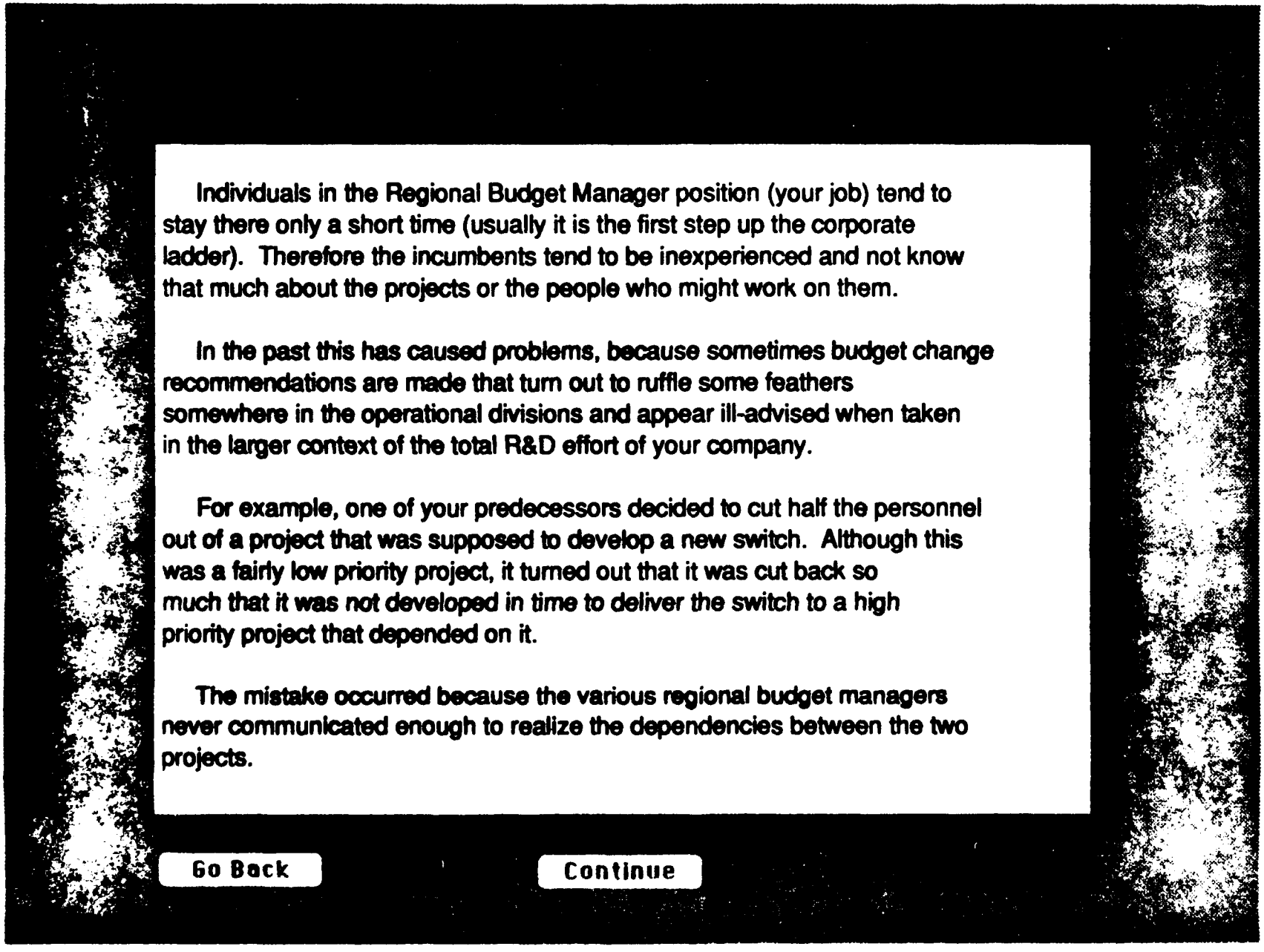


Appendix B- Screen 7





Appendix B- Screen 8


Individuals in the Regional Budget Manager position (your job) tend to stay there only a short time (usually it is the first step up the corporate ladder). Therefore the incumbents tend to be inexperienced and not know that much about the projects or the people who might work on them.
In the past this has caused problems, because sometimes budget change recommendations are made that turn out to ruffle some feathers somewhere in the operational divisions and appear ill-advised when taken in the larger context of the total R&D effort of your company.
For example, one of your predecessors decided to cut half the personnel out of a project that was supposed to develop a new switch. Although this was a fairly low priority project, it turned out that it was cut back so much that it was not developed in time to deliver the switch to a high priority project that depended on it.
The mistake occurred because the various regional budget managers never communicated enough to realize the dependencies between the two projects.
Go Back
Continue

Appendix B- Screen 10

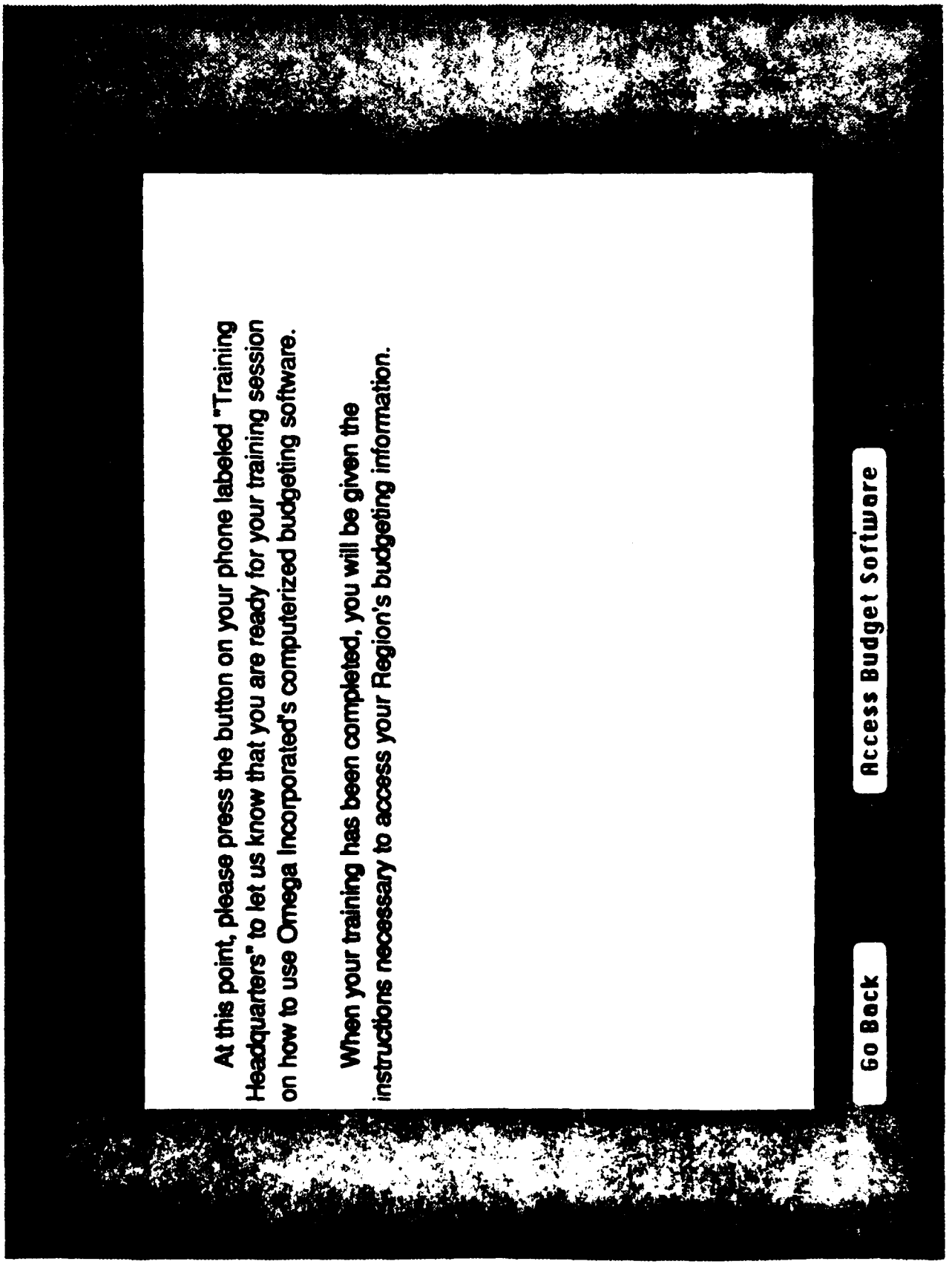
Your lack of experience puts you at a disadvantage when trying to justify your recommendations. In order to help individuals like yourself cope with the enormous amount of budget information, your company has computerized a good deal of the information.

The authorized budgets are stored in "spreadsheet" form. Information about the projects is stored in the computer. Some of this information is general description about the projects and is available to anybody in your company who wishes to see it.

However, much of the information is classified and can be viewed only by you and others who have clearance. The classified information may reveal further technical details about the project as well as what other projects depend on its output.

The classified information should not be directly seen by other people, but should certainly be used when deciding what to cut.

Appendix B- Screen 11



Appendix C
Budgeting Task SuperCard Script Examples

Project Script

Purpose: This script executes when the project is first begun. It allows the programmer to set certain parameters for the project before it allows the user to do anything. In this case, we use it to: affect the display of the menubar, the display format of numbers, command-key functions, disable the arrowkeys, trap for button presses, trap for window closes, trap for classified information access button presses, and to summarize trap information when the project is closed (quit).

```
On StartUp

   hide menubar
   set the numberFormat to 0

End StartUp

On MenuKey COMMAND_KEY

   If COMMAND_KEY is "M" then Set visible of msg to not visible of msg
   If COMMAND_KEY is "Q" then Close all windows
   If COMMAND_KEY is "X" then Cut
   If COMMAND_KEY is "C" then Copy
   If COMMAND_KEY is "V" then Paste
   If COMMAND_KEY is " " then Set visible of menubar to not visible of menubar

End MenuKey



on arrowkey

end arrowkey

on trap
   global trapFile, blank
   put "     button pressed  " into temptext
   write the long time & blank & the short name of target & temptext & Return to file trapFile
end trap

on trapC  -- used to trap a window Close
   global trapFile, blank
   put "     Window Closed   " into temptext
   write the long time & blank & the short name of target & temptext & Return to file trapFile

end trapC

on trapClassified  -- when the classified button is clicked
   global trapFile, blank
   put "   Classified button was clicked to see  " into temptext
   write the long time & blank & temptext & the short name of target to file trapFile
end trapClassified
```

```
on closeProject -- ************************************************************************
   set cursor to busy
   Global trapFile, button_Count, blank
   Global Revised_Region_2, Revised_Region_3, original_count, revised_count
   Global  a1000_count , a2000_count , a3000_count , a4000_count , a5000_count
   Global pa1, pa2, pa3, pa4, pa5  -- personnel
   Global ea1, ea2, ea3, ea4, ea5  -- equipment
   Global ma1, ma2, ma3, ma4, ma5  -- materials and supplies
   Global ta1, ta2, ta3, ta4, ta5  -- travel
   Global sa1, sa2, sa3, sa4, sa5  -- subcontractors

   put " ********************  Summary of Session Begin  *******" into temptext
   Write Return & Return & temptext & return & return to file trapfile
   Write the long time & Return & Return & Return to file trapFile

   writeln

   put "No. of times Region 2 revised =   " into temptext
   write temptext & Revised_Region_2 & Return to file trapFile

   put "No. of times Region 3 revised =   " into temptext
   write temptext & Revised_Region_3 & Return to file trapFile

   writeln

   put " No. of times button for chart Original clicked =  " into temptext
   write temptext & original_count & Return to file trapFile

   put " No. of times button for chart Revised clicked =  " into temptext
   write temptext & revised_count & Return to file trapFile

   writeln

   put " A1000_count      " into temptext
   write temptext &  a1000_count  & Return to file trapFile

   put " A2000_count      " into temptext
   write temptext &  a2000_count  & Return to file trapFile

   put " A3000_count      " into temptext
   write temptext &  a3000_count  & Return to file trapFile

   put " A4000_count      " into temptext
   write temptext &  a4000_count  & Return to file trapFile

   put " A5000_count      " into temptext
   write temptext &  a5000_count  & Return to file trapFile

   writeln

   put " Personnel/Equipment/M&S/Travel/Subcontractors info for A1000 :" into temptext
   write temptext & Return to file trapFile
   write pa1 & blank & ea1 & blank & ma1 & blank & ta1 & blank & sa1 & return & Return to file
trapFile


   put " Personnel/Equipment/M&S/Travel/Subcontractors info for A2000 :" into temptext
```

```
   write temptext & Return to file trapFile
   write pa2 & blank & ea2 & blank & ma2 & blank & ta2 & blank & sa2 & return & Return to file
trapFile

   put " Personnel/Equipment/M&S/Travel/Subcontractors info for A3000 :" into temptext
   write temptext & Return to file trapFile
   write pa3 & blank & ea3 & blank & ma3 & blank & ta3 & blank & sa3 & return & Return to file
trapFile


   put " Personnel/Equipment/M&S/Travel/Subcontractors info for A4000 :" into temptext
   write temptext & Return to file trapFile
   write pa4 & blank & ea4 & blank & ma4 & blank & ta4 & blank & sa4 & return & Return to file
trapFile


   put " Personnel/Equipment/M&S/Travel/Subcontractors info for A5000 :" into temptext
   write temptext & Return to file trapFile
   write pa5 & blank & ea5 & blank & ma5 & blank & ta5 & blank & sa5 & return & Return to file
trapFile

   writeln
   writeln

   close file trapFile

end closeProject

on writeln
   Global trapFile
   write return to file trapFile
end writeln
```

Window: Budget Allocations

Omega Budget Allocations, 90-91

(in Thousands of Dollars)

	Original	Revised
Region 1*	2500	2500
Region 2	2500	2500
Region 3	2500	2500
Total	7500	7500

Click on "Original" or "Revised" Column Label to Plot Allocations

Script for "Revised Field 2"

```
on closeField
 global reg1, reg2, reg3, pro1, pro2, pro3, start3
 put card field "Revised Region 1" into reg1
 put card field "Revised Region 2" into reg2
 put card field "Revised Region 3" into reg3
 put (reg1+reg2+reg3) into card field "Revised Region Total"

 Global trapFile, blank, Revised_Region_2      -- *** begin
 put (Revised_Region_2 + 1)  into Revised_Region_2
 Put "Revised_Field_2" into Field_name
 Write the long time & blank &  Field_name & Return to file trapFile
 put "  Revised Region 2  =  "  into temptext
 Write blank & blank & temptext & reg2  & Return to file trapFile   -- *** end

 put (cd field "Revised Region 1"/cd field "Revised Region Total") ¬
 * 360 into pro1
 put ((cd field "Revised Region 2"/cd field "Revised Region Total") ¬
 * 360) into pro2
 put ((cd field "Revised Region 3"/cd field "Revised Region Total") ¬
 * 360) into pro3
 put the round of pro1 into pro1
 put the round of pro2 into pro2
 put the round of pro3 into pro3
 put the round of (pro1/3.6) & "%" into card field "R1" of cd "RPlot" ¬
 of window "Revised Allocation"
 put the round of (pro2/3.6) & "%" into card field "R2" of cd "RPlot" ¬
 of window "Revised Allocation"
 put the round of (pro3/3.6) & "%" into card field "R3" of cd "RPlot" ¬
 of window "Revised Allocation"
 put pro1 + pro2 into start3
 set the startAngle of graphic "Reg1" of window "Revised Allocation" to 0
 set the arcAngle of graphic "Reg1" of window "Revised Allocation" to pro1
 set the startAngle of graphic "Reg2" of window "Revised Allocation" to pro1
 set the arcAngle of graphic "Reg2" of window "Revised Allocation" to pro2
 set the startAngle of graphic "Reg3" of window "Revised Allocation" to start3
 set the arcAngle of graphic "Reg3" of window "Revised Allocation" to pro3
end closeField

on returnInField
 send tabKey
end returnInField
```

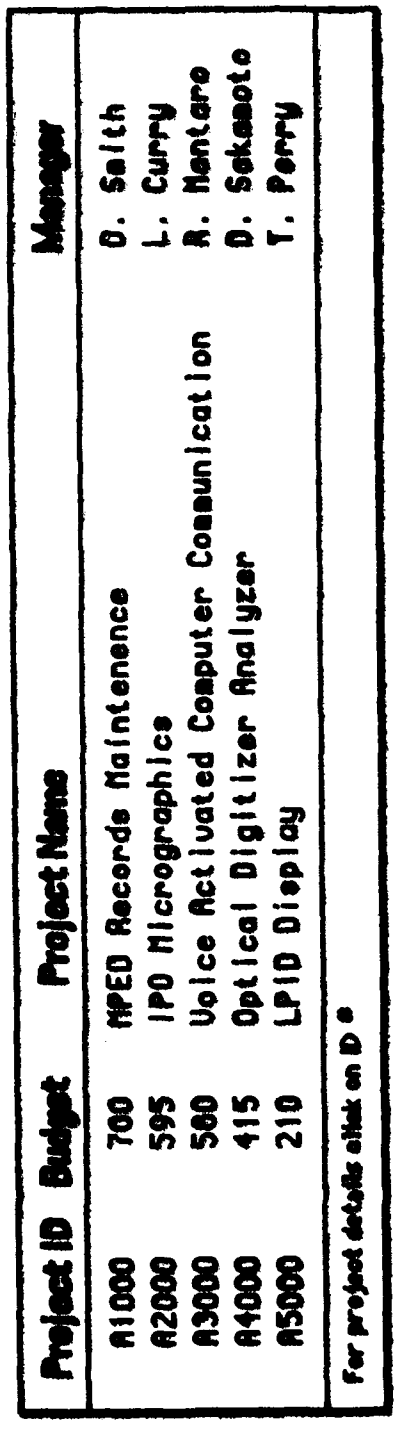
Script of Button to show the "Revised Allocation" plot

```
on mouseUp
 set the cursor to 4
 send closeField to cd field "Revised Region 2"
 open window "Revised Allocation"
 set the cursor to 1

 Global Revised_count
 put Revised_count + 1 into Revised_count
 trap

end mouseUp
```

Window: Project Directory



Project ID	Budget	Project Name	Manager
A1000	700	MPED Records Maintenance	D. Saith
A2000	595	IPO Micrographics	L. Curry
A3000	580	Voice Activated Computer Communication	R. Nantaro
A4000	415	Optical Digitizer Analyzer	D. Sakamoto
A5000	210	LPID Display	T. Perry

For project details click on ID #

Script for Buttons to go to Specific Projects (A1000 example)

Purpose: To allow user to go to the window containing specific information about project A1000. Sets the name of that window so that it lists the project number and the manager of the project (taken from the project directory window). Second part of the script contains the trapping.

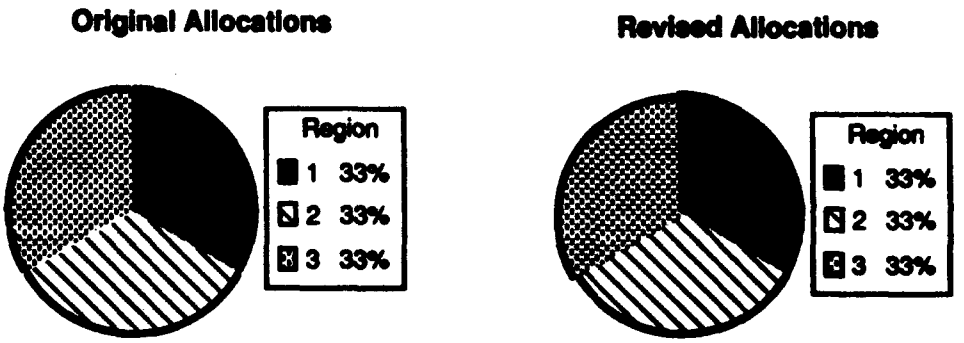
```
on mouseUp
  get the short name of the target
```

```
  set the name of window id 102 to "Region 1          Project #  " & it ¬
  & "          Manager/" & line 1 of cd field "Manager"
  open window id 102

  Global a1000_count, trapFile
  Write Return to file trapFile
  put a1000_count + 1 into  a1000_count
  trap
end mouseUp
```

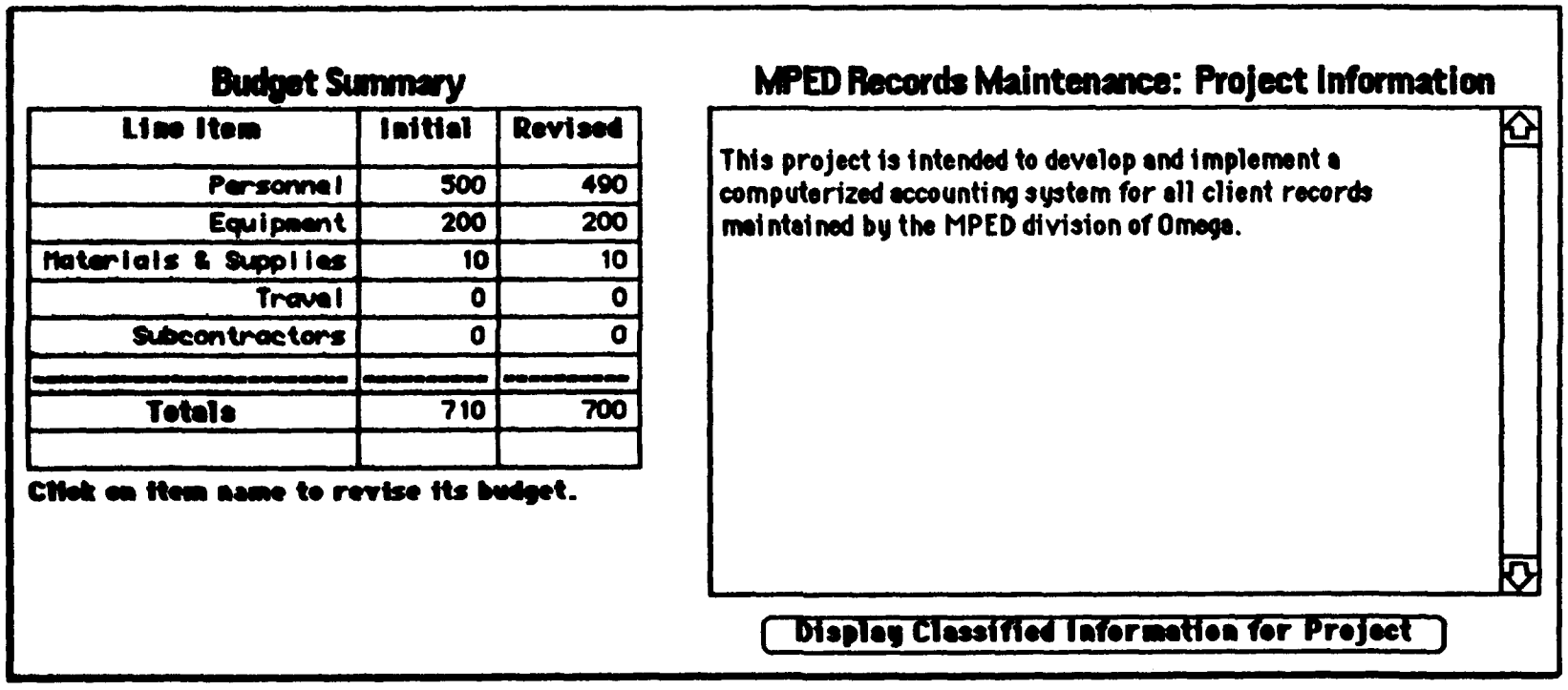
Windows: Original and Revised Allocations

Purpose: These two windows are used to display, at the discretion of the user, the relative distribution of the overall budget across the regions. The original allocations plot does not change and reflects the differences in initial budget allocations. The revised allocation plot changes with every change that is made to the budgets of the projects controlled by the manager or to the revised budget amounts indicated for the other regions in the budget allocation window.



Window: Communications

Purpose: This window was set up to contain the programming that would allow the user to easily invoke Timbuktu: a) to observe the screen of one of their fellow Regional Managers (left section of the window), b) to control other Regional Managers from viewing their screen (middle section of the window), and c) to disconnect observers (right section of the screen). Due to technical difficulties with SuperCard (which does not permit execution of desk accessory menu entries under the Apple menu), we were unable to implement the programming in this window in the way that it was intended. Instead, a custom menubar was implemented which consisted only of the Apple menu (which controls access to desk accessories). Timbuktu access was then available through the desk accessory (which is the way in which it is normally invoked).



Budget Summary

Line Item	Initial	Revised
Personnel	500	490
Equipment	200	200
Materials & Supplies	10	10
Travel	0	0
Subcontractors	0	0
Totals	710	700

Click on item name to revise its budget.

MPED Records Maintenance: Project Information

This project is intended to develop and implement a computerized accounting system for all client records maintained by the MPED division of Omega.

Display Classified Information for Project

Purpose: The project summary window fills the lower portion of the screen and contains summary budget information about personnel, equipment, materials & supplies, travel, and subcontractors line items (left portion of the window) and general information about the project in a scrolling field (right portion of the window). Transparent buttons superimposed over the budget line item names provide access to the appropriate detailed spreadsheet data. In addition, a "Display Classified Information for Project" button appearing under the scrolling field controls access to classified information about the project (which appears in a field which opaquely covers the general information field). The classified information was intended to be accessible only if the "Observers-Not Allowed" option was selected in the communication window.

Script for Button "Display Classified Information for Project"

```
on mouseUp
  set the cursor to 4
  if the hilite of cd button "Allowed" of cd "Comm" of ¬
  window "Communications" is true then
    show cd field id 185
    bringFront
    wait 4 seconds
    hide cd field id 185
    exit mouseUp
  end if
  show cd button "Hide Classified Information for Project"
  show cd field "Classified GenInfo"
  set the cursor to 1
end mouseUp
```

Script for "Budget Line Item" Button (Personnel Example)

```
on mouseUp
  open cd "Personnel" of window "Project 1"
  global pa1
  put pa1 + 1 into pa1
  trap
end mouseUp
```

Window: Budget Itemization: (Personnel Card)

Purpose: This window contains the cards detailing the spreadsheet information for each of the five line items summarized in the project summary window. Managers may type in entries in either the "Revised" or "% Cut" column. The program calculates the appropriate corresponding respective entry. The total revisions and percentage cut of the initial budget is summarized in the last line of the spreadsheet and the changes are then reflected in the appropriate location in the "Project Summary Window".

Budget Itemization: Personnel

Line Item	Initial	Revised	% Cut
Programmers (4)	140	140	0
Programmers (4 @ .50 time)	60	60	0
System Analysts (3)	135	135	0
Lead Analyst (1)	55	55	0
Clerical (1)	20	20	0
Clericals (2 @ .50 time)	20	20	0
Clerical Assistants (2 @ .50 time)	16	16	0
Clerical Temporary (1)	24	24	0
Overtime allocation	20	20	0
---	---	---	---
Totals	500	490	2

Show Cut Priorities Undo All Cuts

Script for Background Button "Show Cut Priorities"

```
on mouseUp
  set the cursor to 4
  get last word of background field "Item" of window "Project 1"
  open cd it of window "Priorities"
  set the cursor to 1
end mouseUp
```

Script for Background Button "Undo All Cuts"

```
on mouseUp
  trap
  set the cursor to 4
   global P1,P2,P3,P4,P5,P6,P7,P8,P9
  if card field "Line2b" is not empty then
    put card field "Line2b" into card field "Line2c"
    put "0" into card field "Line2d"
  end if
  if card field "Line3b" is not empty then
    put card field "Line3b" into card field "Line3c"
    put "0" into card field "Line3d"
  end if
  if card field "Line4b" is not empty then
    put card field "Line4b" into card field "Line4c"
    put "0" into card field "Line4d"
  end if
  if card field "Line5b" is not empty then
    put card field "Line5b" into card field "Line5c"
    put "0" into card field "Line5d"
  end if
  if card field "Line6b" is not empty then
```

```
  put card field "Line6b" into card field "Line6c"
  put "0" into card field "Line6d"
 end if
 if card field "Line7b" is not empty then
  put card field "Line7b" into card field "Line7c"
  put "0" into card field "Line7d"
 end if
 if card field "Line8b" is not empty then
  put card field "Line8b" into card field "Line8c"
  put "0" into card field "Line8d"
 end if
 if card field "Line9b" is not empty then
  put card field "Line9b" into card field "Line9c"
  put "0" into card field "Line9d"
 end if
 if card field "Line10b" is not empty then
  put card field "Line10b" into card field "Line10c"
  put "0" into card field "Line10d"
 end if
 send mouseUp to card button "Revise" of this card
end mouseUp
```

Sample Script for entries in the "Revised" field cells

Purpose: The first part of this script (on closeField) checks to make sure that any change in the revised field does not exceed the initial amount budgeted for that item. If it does, a warning is flashed (by showing a hidden field "Bad Entry1") and the entry is changed back to the initial amount. After that correction, or if the entry is a valid one, then the script for the card button "Revise" is executed. The second portion of the script (on returnInField) sends a tabKey whenever the return key is pressed (which then advances the cursor to the next valid field in the column).

```
on closeField
 if cd field "Line2c" > cd field "Line2b" then
  show background field "Bad entry1"
  wait for 2 seconds
  hide background field "Bad entry1"
  put cd field "Line2b" into cd field "Line2c"
  select text of cd field "Line2c"
 end if
 put the round of (((cd field "Line2b" - cd field "Line2c")/(cd ¬
 field "Line2b"))*100) into cd field "Line2d"
 send mouseUp to cd button "Revise"
end closeField

on returnInField
 send tabKey
end returnInField
```

Sample Script for entries in the "% Cut" field cells

Purpose: The first part of this script (on closeField) checks to make sure that the percentage cut entered does not exceed 100%. If it does, a warning is flashed (by showing a hidden field "Bad Entry2") and the entry is changed back to 0%. After that correction, or if the entry is a valid one (between 0-100%), then the script for the card button "Revise" is executed. The second

portion of the script (on returnInField) sends a tabKey whenever the return key is pressed (which then advances the cursor to the next valid field in the column).

```
on closeField
 if cd field "Line2d" > "100" then
  show background field "Bad entry2"
  wait for 2 seconds
  hide background field "Bad entry2"
  put "0" into cd field "Line2d"
  select text of cd field "Line2d"
 end if
 put the round of (cd field "Line2b" - (cd field "Line2b" * ¬
 (cd field "Line2d"/100))) into cd field "Line2c"
 send mouseUp to cd button "Revise"
end closeField

on returnInField
 send tabKey
end returnInField
```

"Revise" Button Script

Purpose: This button updates the appropriate totals for the revised budget and inserts it in the appropriate spot in the last line of the spreadsheet and also in the appropriate location in the project summary window. The script then executes the "Budget Update" button.

```
on mouseUp
 set the cursor to 4
  global P1,P2,P3,P4,P5,P6,P7,P8,P9
 put card field "Line2c" into P1
 put card field "Line3c" into P2
 put card field "Line4c" into P3
 put card field "Line5c" into P4
 put card field "Line6c" into P5
 put card field "Line7c" into P6
 put card field "Line8c" into P7
 put card field "Line9c" into P8
 put card field "Line10c" into P9
 put (P1+P2+P3+P4+P5+P6+P7+P8+P9) into card field "RTotal"
 put card field "RTotal" into card field "Line2c" of ¬
 cd "Summary 1" of window id 102
 send closeField to card field "Line2c" of ¬
 cd "Summary 1" of window id 102
 if cd field "Ptotal" is "0" then
  put "0" into cd field "Line12d"
 else
  put round (((cd field "PTotal"-cd field "Rtotal")/cd field "PTotal")*100)¬
  into cd field "Line12d"
 end if
 send mouseUp to background button "Budget Update"
 if the visible of window "Revised Allocation" is true then
  send closeField to cd field "Revised Region 2" of cd "Budget" of¬
  window "Budget Allocations"
 end if
end mouseUp
```

Script for Background Button "Budget Update"

Purpose: This button totals up the updated budget numbers shown for each project in the project directory window and updates the region total shown in the "Budget Allocations" window.

```
on mouseUp
  put ((cd Field "Rtotal" of cd "Summary 1" of window id 102)+¬
  (cd Field "Rtotal" of cd "Summary 2" of window id 103)+¬
  (cd Field "Rtotal" of cd "Summary 3" of window id 104)+¬
  (cd Field "Rtotal" of cd "Summary 4" of window id 105)+¬
  (cd Field "Rtotal" of cd "Summary 5" of window id 106)) into¬
  cd field "Revised Region 1" of cd "Budget" of window "Budget Allocations"
  send closeField to cd field "Revised Region 1" of cd "Budget"¬
  of window "Budget Allocations"
end mouseUp
```

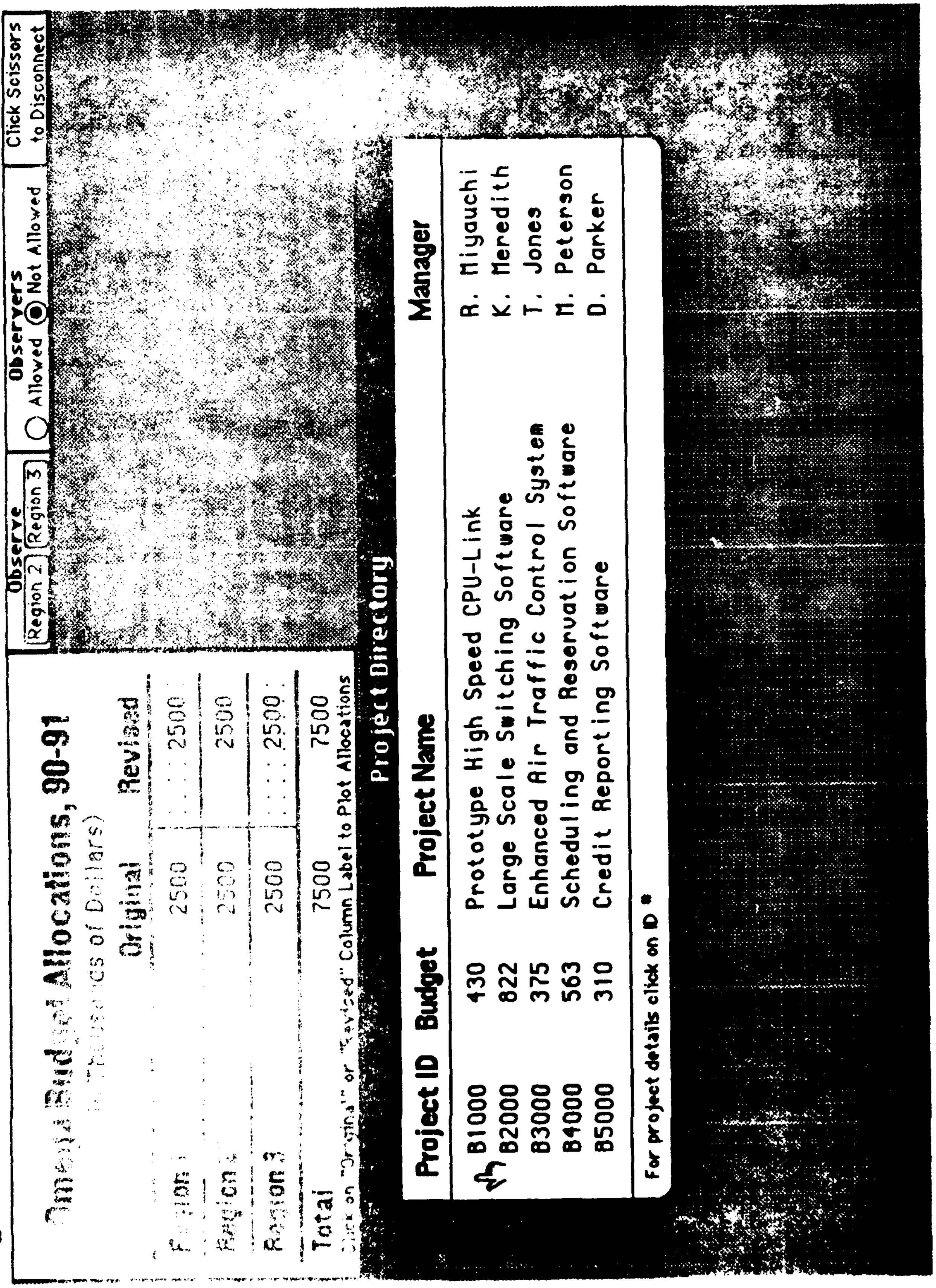
Window: Priorities (Personnel Card)

Purpose: The five cards in this window correspond to each of the budget line items and provide guidelines to the regional managers as to the cut priorities generally set forth by the organization (unless otherwise indicated). This window is invoked by the user by pressing the "Show Cut Priorities" button in the Budget Itemization windows.

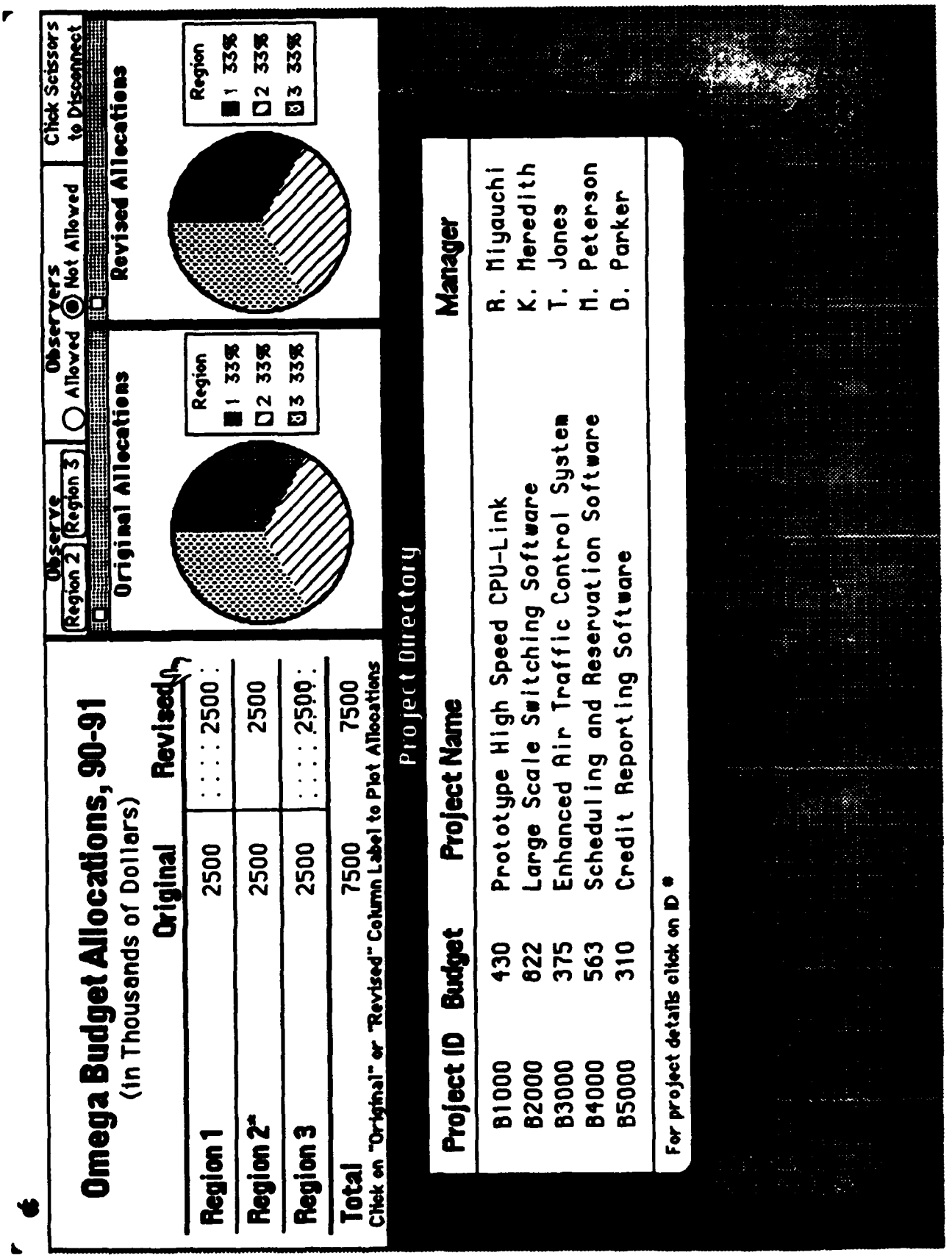
Personnel Priorities

1. Full time professional employees
2. Full time technical employees
3. Part time professional employees shared with other projects
4. Full time clerical workers
5. Part time technical employees
6. Part time clerical workers
7. Consultants
8. Temporary workers
9. Overtime

Appendix D- Screen 1
Region 2 Sample Task Session Screen Displays



Appendix D- Screen 2



Omega Budget Allocations, 90-91

(in Thousands of Dollars)

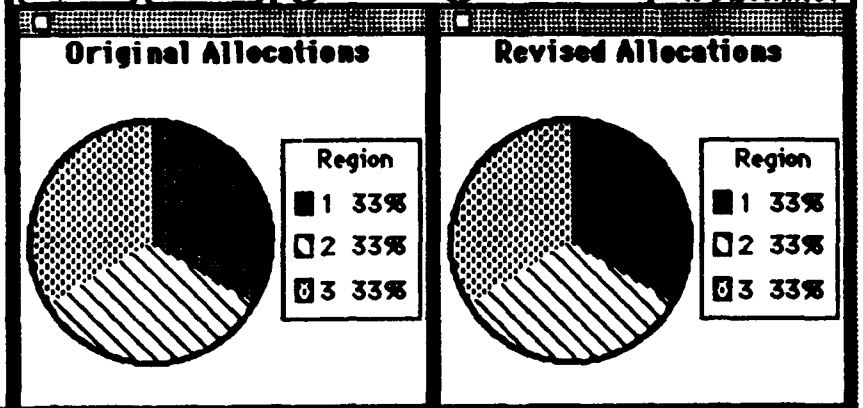
	Original	Revised
Region 1	2500	2500
Region 2*	2500	2500
Region 3	2500	2500
Total	7500	7500

Click on "Original" or "Revised" Column Label to Plot Allocations

Observe: Region 2 | Region 3

Observers: Allowed | Not Allowed

Click Scissors to Disconnect



Region 2 Project # B1000 Manager R. Miyauchi

Budget Summary

Line Item	Initial	Revised
Personnel	355	355
Equipment	30	30
Materials & Supplies	10	10
Travel	35	35
Subcontractors	0	0
Totals	430	430

Click on item name to revise its budget.

Prototype High Speed CPU-Link

This project is to link various high speed CPU's through a combination of hardware/software which is being developed internally in your organization. This project will have immediate commercial applications.

Display Classified Information for Project

Appendix D- Screen 3

Omega Budget Allocations, 90-91

(in Thousands of Dollars)

	Original	Revised
Region 1	2500	2500
Region 2*	2500	2500
Region 3	2500	2500
Total	7500	7500

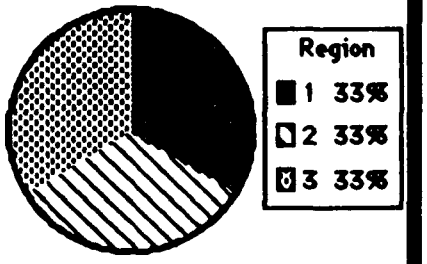
Click on "Original" or "Revised" Column Label to Plot Allocations

Observe: Region 2 | Region 3

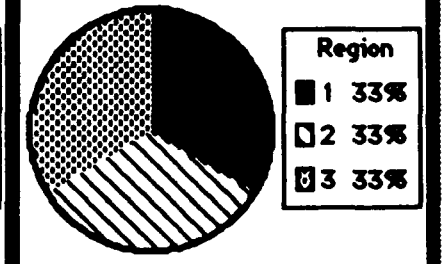
Observers: ○ Allowed ◉ Not Allowed

Click Scissors to Disconnect

Original Allocations



Revised Allocations



Region 2 Project # B1000 Manager: R. Miyauchi

Budget Summary

Line Item	Initial	Revised
Personnel	355	355
Equipment	30	30
Materials & Supplies	10	10
Travel	35	35
Subcontractors	0	0
Totals	430	430

Click on item name to revise its budget.

Prototype High Speed CPU-Link

********** CLASSIFIED INFORMATION **********

OMEGA Priority-- 13/15 Your Region Priority-- 3/5

This project has been heavily supported in the past by vice-presidents in your company. Although the total amount of money is rather small, the payoff if it is successful could be tremendous.

PERSONNEL

Full time engineers shuld not be cut. This project was used to hire top notch people. In addition, consultant is very important to project.

Hide Classified Information for Project

Omega Budget Allocations, 90-91

(In Thousands of Dollars)

	Original	Revised
Region 1	2500	1250
Region 2*	2500	2265
Region 3	2500	1500
Total	7500	5015

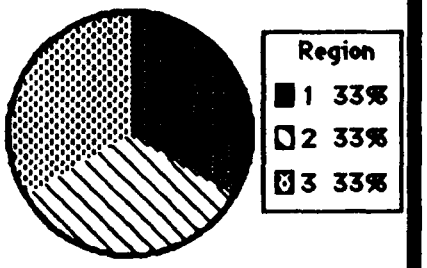
Click on "Original" or "Revised" Column Label to Plot Allocations

Observe: Region 2 | Region 3

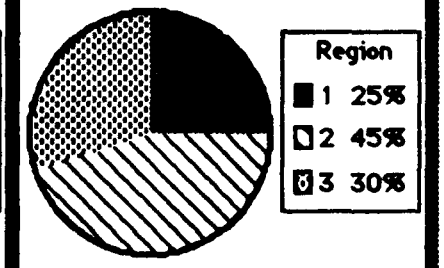
Observers: ○ Allowed ◉ Not Allowed

Click Scissors to Disconnect

Original Allocations



Revised Allocations



Region 2 Project # B1000 Manager R. Miyauchi

Budget Summary

Line Item	Initial	Revised
Personnel	355	120
Equipment	30	30
Materials & Supplies	10	10
Travel	35	35
Subcontractors	0	0
Totals	430	195

Click on item name to revise its budget.

Budget Itemization: Personnel

Line Item	Initial	Revised	% Cut
Engineers (3)	135	45	67
Technicians (4)	100	25	75
Clerical (2)	40	20	50
Technical Assistant (1 @ .50 time)	10	0	100
Consultants (30 days)	30	0	100
Overtime Allocation	40	30	
Totals	355	120	66

Show Cut Priorities | Undo All Cuts

Appendix D- Screen 6